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ABSTRACT

This study tested the hypothesis that children with weaker speech ability have greater difficulties in perception, powers of reasoning and spatial orientation than children with better speech ability, and assessed the value of Apgar scores as a predictive measure of later linguistic disorders. Subjects were 100 children born in 1970 who attended five day care homes in Helsinki and Ispoo, Finland. Subjects' birthweight and Apgar scores were obtained. Speaking ability (vocabulary, articulation, word formation, sentence structure) was assessed, and subjects were placed into four groups based on their score. The BMA test battery, an adaptation of the Borel-Maisonny tests, was used to measure auditory discrimination, tactual and olfactory discrimination, logic and reasoning, spatial ability, motor orientation, and laterality. Results indicated that (1) children belonging to the weakest speech ability groups experienced greater difficulties in auditory perception, reasoning, and spatial orientation than those in the strongest ability groups, and (2) low Apgar scores were symptomatic of linguistic disorders. There are 28 pages of appendices, including tabulations of results for each measure. (SB)

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ON THE PRIMARY FACTORS AFFECTING LINGUISTIC ABILITY IN PRE-SCHOOL CHILDREN

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1 INTRODUCTION

My thesis work, "On the Defects of Perception, Reasoning and Spatial Orientation Ability in Linguistically Handicapped Children" (Alahuhta 1976[1]), demonstrated that linguistically handicapped children (that is children with articulatory defects, reading and writing disabilities, backward children with speech defects attending special schools, stammerers, CP children, children with defective hearing, aphasic children and cases of dyslalia gravis), taken as a whole, suffered to a significantly greater degree from defects in perception, reasoning and spatial orientation than did a control group composed of 7 - 11 year old schoolchildren.

The investigation also demonstrated that certain special problems were as common to those groups with reading and writing disorders as to those suffering from speech disorders proper. Those special problems which belonged to the area of auditory discrimination consisted of a poor ability to distinquish frequency and duration of sounds and to manipulate auditory units rhythmically. Other difficulties shared by these groups were also to be found in the area of the understanding of spatial relations and that of motor orientation.

This result strongly confirmed the view which I put forward in the introduction to the above-mentioned work, namely, that

one should recognize the strong connection between speaking, reading and writing, not only as these interrelate in the normal course of development, but also when they are impaired. And in this connection I referred the reader to, for instance, the following authorities: Viitamäki (1959), Russell-Espir (1961), Hécaen-Angelergues (1965), Delacato (1967), Husson (1967), Lenneberg (1967), Luria (1970), Espir Rose (1970), Bannatyne (1971), Knura (1973), Borel-Maisonny and Roudinesco (Aimard 1974).

Of the above-mentioned R. Husson's description of the cerebral mechanism involved in speaking, reading and writing was particularly interesting. It also seemed to provide a good opportunity not only of illustrating the connection between speaking, reading and writing in a concrete way, but also of helping me clarify the part played by primary symptoms, discovered in the course of my investigations, as causative factors not only in speech but also in reading and writing disorders.

I have already dealt with the subject in question in Finnish in Publication No. 30 for the Phonetics Institute of the University of Helsinki (Alahuhta 1976_2). However, I should like to return to some of the more central issues dealt with in this publication, since it was the conclusions I drew there that provided the motivation of the present study.

According to Husson, 16 different systems exist which together explain the principal features of the cerebral mechanism involved in both the spoken and the written language (Husson

1967). Of these systems, the following five are connected with the forming and activating of different engrams:

1. The forming and activating of audio-verbal engrams (System IV).
2. The forming and activating of pharyngo-buccal proprioceptive engrams (System VI).
3. The forming and activating of digito-manual proprioceptive engrams (System XIII).
4. The forming and activating of visual engrams (System X).
5. The forming and activating of polysensory meaning content engrams (System II).

My thesis discussed the following common primary symptoms, which can be found in the background of speaking, reading and writing disorders: problems in auditory discrimination, rhythm manipulation, motor orientation ability, visual discrimination ability and spatial perception and orientation.

When the primary symptoms mentioned were examined, together with the above-listed systems which form and activate the engrams, the following conclusions could be drawn:

The problems of auditory discrimination and rhythm manipulation produce faulty audio-verbal engrams. When these faulty engrams are then activated to produce speech, reading and writing, errors also appear in all these activities.

The problems of motor orientation ability (which presupposes somatognosia and kinesthetic and proprioceptive ability), together with defectiveness

in tactual discrimination ability, are jointly responsible for the creation of faulty pharyngo-buccal and digito-manual proprioceptive engrams. The faulty engrams in question bring about disorders in speaking, reading and writing.

The problems of visual discrimination, spatial perception and orientation impede the forming of visual engrams, and thus hamper the reading and writing process.

Strong background symptoms also have a disturbing effect on the forming of polysensory meaning content, and thus impede the reception and application of concepts and the understanding of language in general.

The concepts of some researchers in connecting the above-mentioned background symptoms with linguistic problems

With regard to the effect of defective auditory discriminating ability on articulation, researchers have produced the following findings:

Images of sounds and words erroneously assimilated also produce further erroneous sounds and words (Seeman, Schäfer 1973).

Defective articulation can also be connected with audio-verbal perception. When the child is incapable of perceiving the acoustic finesses of different phonemes, he

is also incapable of pronouncing them correctly (Goldsmit 1976).

The connection between the degree of auditory discrimination ability and reading and writing ability has also been investigated. The head of a certain experimental school in Finland states:

"Discrimination ability based on auditory perception is an even better predictor of a child's reading potential than visual discriminating ability." (Rissanen 1975).[1)]

The investigations of de Hirsch and Jansky (1968 and 1970) showed that those second form children who were completely unsuccessful in reading and writing exercises prossessed an exceptionally weak ability to make observations by means of the sense of hearing and that some of them also suffered from considerable articulation difficulties.

According to various researchers, faulty articulation is also caused not only by actual motor difficulties but also by the inability to control pharyngo-buccal motor activity (Goldsmit 1976), or by defective somatognostic perception (Mac Weilage, Rootes, Chase 1967). According to Sovak, disorders in the motor area of speech and in writing are caused by unstable or contradictory laterality, which for its part is closely connected with orientation from right to left. (Sovak 1968)

On the other hand, the lack of temporal-spatial organization

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1) Lecture in Kaarina 1975-04-01

in particular, which is responsible for the failure to develop the body image, also produces dyslexia (Muccelli and Burcier 1963, Belmont and Birch 1965, Ferdinand and Müller, Noël 1976).

Borel-Maisonny and Taillefer have classified the various faults as belonging to the phoneme, word or sentence levels, respectively (Brunet 1966). Faults in articulation create problems on the phoneme level, faults in speech on the word level and faults in language on the sentence level.

Of the problems in question, difficulties in speaking and particularly in articulating are significantly connected with the problems of the written language and are contributory factors in dyslexia, dysorthographia and in certain cases dysgraphia, too.

Since the part played by the background symptoms mentioned above in creating disorders in speaking and reading as well as in writing has been generally recognized and has been illustrated and proved in various studies, one would seem justified in attempting to discover the existence and type of these background disorders at as early a stage as possible in the child's linguistic development. This being the case, therapy could be introduced to treat the background symptoms observed before these create problems in reading and writing as well.

The aims of the present work - on the background factors that influence the linguistic ability of pre-school children -

are based on the attempt to clarify the problems described above as these relate to the situation of pre-school children.

2. AIMS OF THE STUDY

In embarking on the present study of pre-school children, my first aim was to evaluate the BMA test, which I have used as a study method in the investigation of children of pre-school age. (The BMA test consists of a test battery based on the Borel-Maisonny tests and adapted and evaluated by Eila Alahuhta.) It was, after all, obvious that the average performance profile of these children would differ from that of children of school age, at least as regards those test items which are most sensitive to the age of the test subject.

In order to analyze in greater detail than in previous studies the factors that affect the performance profile of pre-school children - in the areas of perception, reasoning and spatial orientation ability - a table of variables was drawn up, which consisted not only of sex, handedness and exactness of age to within one and a half months, but also included the test subjects's weight at birth and Apgar score[1] rating. This

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1) The American Virginia Apgar (1909-) introduced the well-known Apgar scoring system in 1952, publishing an account of her work in this field in the following year. The Apgar score is based on heart rate, respiratory effort, muscle tone, reflex irritability and colour.
A useful mnemonic is
A - Appearance (colour)
P - Pulse (heart rate)
G - Grimace (reflex irritability)
A - Activity (muscle tone)
R - Respiratory effort (APGAR 1953)
Apgar continued her work, publishing a second report in 1958 (APGAR 1958).

rating consists of the sum of those points which the child is given in the clinical examination that follows immediately on birth, and which are based on the following factors: 1) colour, 2) heart rate, 3) reflex irritability, 4) muscle tone, 5) respiratory effort. The maximum number of points awarded for each of these factors is two. Hence, the ideal result is an Apgar score of ten. The aim was to investigate the possible dependency of the performance on the above-mentioned factors, and to compare the significance of the mean differences, as regards the factors in question, to be found in the various observation unit groups set up.

An earlier study had already demonstrated that those children with problems of speaking, reading and writing also suffer from greater difficulties in perception, powers of reasoning and spatial orientation than those children who have no linguistic problems (Alahuhta 1976_1).

The same study, moreover, provided grounds for regarding the above-mentioned primary difficulties as factors that indicate future reading and writing disorders in those children who have not yet started school.

So that an opportunity might present itself in this study, too, of showing a possible interdependence between the test performances and speech disorders discovered in the children used in the sample, and, on the other hand, of comparing the significance of the average differences of the performance results of children representing various speech levels, I also considered it important to carry out a survey, on the basis

of which the test subjects could be divided into different speech groups according to ability.

Although the investigation was thus designed to deal with the problems of the linguistically handicapped child from many angles of approach, so that those with disorders and those susceptible to disorders in later linguistic development could, at as early a stage as possible, be separated into groups for the purposes of therapy or placed in risk groups for special observation, the study only attempted to examine one hypothesis:

> Those belonging to the weakest speech ability groups have greater difficulties in perception, powers of reasoning and spatial orientation than those belonging to the better speech ability groups.

3. THE COURSE OF THE INVESTIGATION

3.1. SUBJECTS

The test subjects were taken for the most part from municipal day-care homes of the city of Helsinki. I obtained special permission for this from the Day-Care Home Board of the city of Helsinki, from the wardens of the day-care homes and from the children's parents. Ten per cent of those tested came from the Metsola day-care home of the town of Espoo.

I conducted the investigation in three day-care homes in the Töölö area of Helsinki and in one in the Lauttasaari area. I selected these locales primarily because all of them contained a large number of pre-school children (born 1970).

The total number of test subjects comprised 100 children, 90 of whom were tested in Helsinki and ten in Espoo.

In the Töölö day-care homes, all of which represented so-called normal day-care homes, all those pre-school children were

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1. TOPELIUS, 15 children, i.e. all the pre-school children attending the home
2. PÄIVÄPIRTTI, 28 children, i.e. all those pre-school children who were present in the home on the day the testing took place and whose parents had given permission for their participation in the investigation
3. LEPPÄSUO, 26 children, i.e. - " -

tested whose parents had given their permission and who were available on the appropriate test days.

The fourth of those Helsinki day-care homes (Katajaharju) in which I carried out my investigations is run along special lines. Some of the children there suffer from speech disorders for which they receive daily therapy in the home itself. In this day-care home I tested those 20 children who, during the four day period of testing, were most readily available. Nine of these children belonged to those receiving speech therapy. (The effect of therapy on performance results may, however, be very slight, since testing was carried out at the very beginning of term when speech therapy had been given for only a short time.)

The selection of one of the Espoo municipal day-care homes as a testing place sprang from the fact that there, too - as in one of the Töölö day-care homes - the opportunity arose for studying triplets. I felt that the investigation of two sets of triplets born in the same year would provide a feature of interest in the discussion of the results. In Espoo, I tested not only the triplets but also seven other children, whose parents had been previously contacted. Thus, the total number of children tested in Espoo was ten.

3.1.1. The sex and age of the subjects

The group of test subjects, selected at random, was divided quite evenly as regards sex. Girls accounted for 49% of those tested and boys for 51%.

As has been mentioned above, all the test subjects were born in 1970. The tests were carried out between 24th August and 15th October 1976. The oldest of the testees at that time were six years and nine months and the youngest five years and nine months. Hence, the degree of fluctuation in age was one full year.

Since it was also my intention to examine as carefully as possible the effect of age on performance results, and as my material consisted of just those pre-school children, the five to six year olds, who represent a certain kind of "transition age", an age when great somatic and psychological changes occur in the child, I divided the test subjects into five different age groups. (Gesell-Ilg 1954)

The age groups were as follows: 1. 5 years 9 months; 2. 6 years; 3. 6 years 3 months; 4. 6 years 6 months and 5. 6 years 9 months. Grouping of the test subjects into different age groups was based on the age they were closest to. Thus, for instance, a child aged six years eight months was placed in the fifth group, whereas a child aged six years, four months and fourteen days was placed in the third group. The margin of error as regards age was, therefore, one and a half months at most.

The division into age groups was as follows:

1.	2.	3.	4.	5.
5 y. 9 m.	6 y.	6 y. 3 m.	6 y. 6 m.	6 y. 9 m.
16%	19%	18%	29%	18%

The average age of the testees was, therefore, 6 y. 3 m. 13 days.

3.1.2. Weight of subjects at birth

In attempting also to illustrate the dependency of performance ability on weight at birth, special attention was paid to extreme values. Exceptionally high figures or ones considerably below normal for weight at birth were those of greatest interest to me.

I acquired information on the subjects' weight at birth either from the day-care home records or the children's clinic records. I obtained some of the information direct from the different clinics via the consultant doctor for the clinics. The same doctor provided me with information - or verified information already obtained - concerning the so-called Apgar score which the subjects had been given when newly born.

The largest figure for weight at birth turned out to be 4 kg. 900 gr. and the smallest 1 kg. 370 gr. The measure of difference in weight was, therefore, 3 kg. 530 gr. I divided the test subjects according to weight at birth into ten

different groups as follows:

1.	under 2500 gr.;	2.	2500 gr. - 2750 gr.;
3.	2760 gr. - 3000 gr.;	4.	3010 gr. - 3250 gr.;
5.	3260 gr. - 3500 gr.;	6.	3510 gr. - 3750 gr.;
7.	3760 gr. - 4000 gr.;	8.	4010 gr. - 4250 gr.;
9.	4260 gr. - 4500 gr.;	10.	over 4500 gr.

The percentage division of test subjects into groups according to weight at birth was as follows:

1.	2.	3.	4.	5.
7%	5%	8%	13%	19%
6.	7.	8.	9.	10.
23%	7%	7%	-	4%

The weight at birth of seven of the test subjects was not ascertained.

Extreme values: under 2500 gr. at birth = 7%; over 4500 gr. at birth = 4%. Over half of the weights, or 55%, was concentrated between 3000 gr. and 3750 gr.

3.1.3. The subjects' Apgar point rating

Not all Apgar scores for the test subjects could be obtained from the clinic records. I acquired some of the information from the archives of the Maternity Hospital (Naistenklinikka), the Pediatric Hospital (Lastenklinikka) and the Mehiläinen Hospital, on the appropriate direction from the mothers concerned. For eight of the subjects, however, there is no

information regarding Apgar scores.

24% of the test subjects had a score of ten points, 45% had nine points and 8% eight points. Information with regard to 8 per cent, therefore, was missing. Furthermore, the test sample included 15% whose Apgar scores were such that I was compelled to use my own discretion. For example, those test subjects whose scoring progressed 5/4/7/10, 4/6/10 and 7/7/9 were placed in the 8 APG group in the table of variables.

When it is considered necessary to carry out several point evaluations, examinations are conducted after the first examination (performed one minute after birth) in principle five minutes, ten minutes and a further ten minutes later. The procedure; however, varies a great deal in practice. In some Finnish hospitals the second score is given after only three minutes and in others the third after only fifteen minutes. Such serial values would not on the whole constitute absolutely suitable standards.

The final division as regards Apgar scoring is as follows:

10 Apgar points group	24%
9 - " -	52%
8 - " -	16%
Information lacking	8%

The solution presented above, in which 8 is marked down as the final Apgar score, can be accounted for on the grounds that in comparing the performance of certain test items by the test subjects in question with the performance of those

who had scored 10 or 8 from the very beginning, it corresponded most closely with the performance of the latter.

3.2. DETERMINATION OF SPEAKING ABILITY

In order to determine the subjects speaking ability a quick survey was carried out before the actual testing began. The aim of this was to clarify the possible different levels of ability of the subjects as regards the following factors:

- the mastery of a particular but limited vocabulary
- speed of speaking
- articulation
- mastery of certain word formations
- sentence structure

Mastery of these factors determined the later division of the testees, according to the total score obtained, into four different speech ability groups.

The test material comprised 12 picture cards from Père Castor's series of pictures[1)], together with the first picture card of the 16 Borel-Maisonny cards designed for use in the measuring of powers of linguistic expression in $1^{1}/2$-6 year olds. (Borel-Maisonny 1967, Castor 1969)

---

1) comprising 512 pictures designed to develop the language of small children

The selction of picture cards was determined according to the following criteria:

- it was assumed that the objects depicted on the picture cards were familiar to the testees,
- the naming of these objects would reveal to the examiner the subjects' most central articulation defects,
- the pronunciation of certain words would also reveal the ability or lack of ability to master word formations that were slightly more difficult (for example, traktori (tractor) and harava (rake)).

  The word traktori was regarded as extremely suitable as a test word, because the sound clusters it containes demand of the child a well-developed mastery not only of motor but also of auditory word formation.

The cards showed pictures of the following objects to be named: nappi (button), lamppu (lamp), susi (wolf), sipuli (onion), suksi (ski), koululaukku (satchel), perhonen (butterfly), harava (rake), silitysrauta (flat-iron), hammasharja (tooth-brush), polkupyörä (bicycle) and traktori (tractor).

The picture card belonging to Borel-Maisonny linguistic testing depicted a scene of a small boy taking his dog for a walk.

3.2.1. Vocabulary

Each of the subjects was shown all twelve picture cards and asked, "What is this?" When the answer was correct, the subject was awarded a score of 0 points (no mistakes). Giving the wrong name scored one point.[1)]

As regards vocabulary, the overall result was as follows:

0 points	94%
1 point	6%

3.2.2. Speed of speaking

A continuous check was kept on the speed of speaking throughout the tests. Point mistakes were marked down only when the speed of speaking, due to awkwardness in the motor area, was exceptionally slow (one point mistake) or when excessive speed or lack of clarity produced speech that was practically a babble (two point mistake).

As regards speaking speed, the overall result was as follows:

0 points	85%
1 point mistake	12%
2 point mistake	3%

---

1) e.g. the iron was called a vacuum cleaner, the wolf a lion or the ski a skate. Moreover, the child who called a wolf a lion, looking at the absurd pictures, called a beak a foot and he thought a leaf was a peapod - herneenpalko (peapod) he called hernepalmikko (lit. 'a pea plait').

3.2.3. Articulation

The principles for scoring on the basis of articulation were as follows: When no mistakes at all were made, the result was marked down as 0 points. If 's' was articulated incorrectly, it constituted a one point mistake, and the wrong articulation of 'r' produced a two point mistake. When several sounds were omitted, a result of four points was marked down.

As regards articulation, the overall result was as follows:

No mistakes of articulation at all (0 points)	42%
Only the 's' articulated incorrectly (1 point)	30%
Only the 'r' articulated incorrectly (2 points)	12%
Both 'r' and 's' articulated incorrectly (3 points)	14%
Other mistakes as well (4 points)	2%

The reason for marking down the incorrect articulation of 's' only as a one point mistake springs from the fact that the cause of faulty pronunciation in most of the test subjects was quite clearly due to the defective condition of the milk teeth, natural to that age group. In the determination of speaking ability, the mere 's' mistake did not affect the overall result negatively, as the classification of ability to be presented later will show.[1)]

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1) All other sound faults are regarded as functional.

3.2.4. Word formations

In the different word formations the only clear mistakes occurred in enunciating the words harava and traktori, the formation of which, as had been expected, varied considerably. One case of dysphasia that revealed itself in the naming of objects, when the word formation only became clear after faltering and by trial and error, was also classified in this group of mistakes.

Principles of scoring:

Word formations completely correct	(level 1 = 1)
Mistakes with the word traktori	(level 2 = 2)
Other mistakes as well	(level 3 = 3)

Mispronunciations of the word traktori were quite common, in spite of the fact that the requirement for a faultless result for this word did not presuppose that the word would be spontaneously pronounced in the correct way. Whenever the subject, in referring to the picture of a traktori, mispronounced the word, he was given another chance to try again with the test instructor pronouncing the word first.

The pronunciation of the word traktori revealed the following erroneous forms:

/rattori/, /ratkori/, /raktori/, /kraktori/, /trattori/, /rakstori/, /vraktori/, /krakkori/, /daktori/, /krattori/, /taktori/, /tratkori/, /kratkori/, /hraktori/, /vagtori/, /ratrori/.

The most common mispronunciations were /raktori/ and /kraktori/. Both forms occurred eight times. The mispronunciations /rattori/ and /tratkori/ occurred three times. The forms /taktori/ and /hraktori/ occurred twice, other errors of pronunciation occurring in individual cases.

The overall result for word formations was:

(1)	Word formation correct	61%
(2)	Errors with the word traktori	36%
(3)	Other mistakes as well	3%

3.2.5. Sentence structure

The device used in the investigation of the ability to construct sentences was a picture card on which there was depicted a boy in short trousers taking his dog for a walk. The subject was shown the picture and told: "Look at this picture and tell me what you see." When the reply was in the form of a complete sentence, for instance, "It's a little boy training his dog", or "It's a boy taking his dog out for a walk", the result was recorded as level 1. If the sentence was incomplete, for instance, "a boy with his dog", the result was marked down as level 2. A reply consisting of only two words following each other or then with the addition of the word 'and' represented the poorest result and was recorded as level 3. (For example, "a dog, a boy", "a dog, a person", "boy and doggie", "dog and boy" etc.)

The overall result for sentence structure was:

(1)	level 1	62%
(2)	level 2	14%
(3)	level 3	24%

3.2.6. Speaking ability as a whole

The overall level of speaking was determined by adding together first of all the scores obtained for vocabulary, speed of speaking, articulation, word formation and sentence structure. Subjects with two points accounted for 21%, subjects with 3 points for 22%. These constituted the first ability group, which thus comprised altogether 43% of test subjects with the best speaking ability, that is those subjects whose speech was more or less free from error. Subjects with four or five points, who made some mistakes, represented 31% altogether and were placed in the second ability group, and that 19% whose overall score was 6 or 7 points, that is who had made rather a lot of mistakes, were classified in the third ability group. The weakest ability group was made up of those whose overall score was 8, 9, or 10. 7% of the testees were placed in this group. Their speech was full of mistakes.

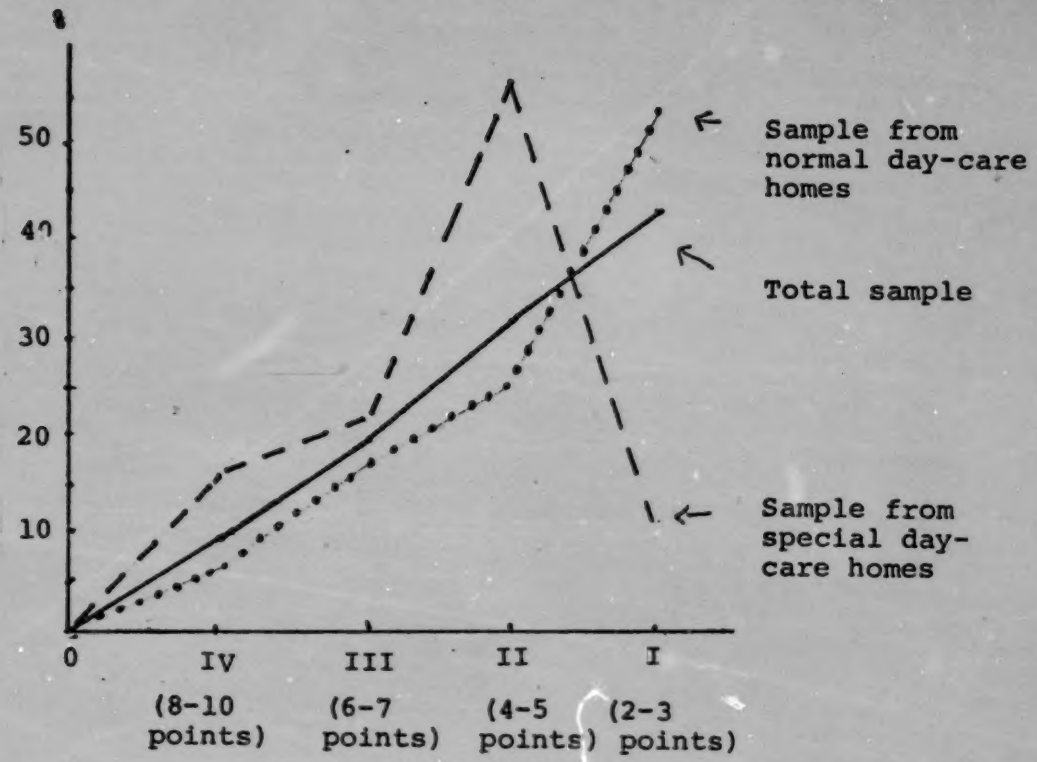

FIGURE 1. Levels of speaking ability

Since the day-care home in the Lauttasaari district of town - a kind of special day-care home - did not have the same pupil structure as the other day care homes, figure 1 illustrates not only the division of the whole random sample into speech ability groups, but for the sake of comparison also the division of pupils of that particular day-care home and also the division into speech ability groups of the other "normal" day-care homes.

The figure clearly shows that the division as regards the special day-care home - in which some of the pupils are given speech therapy in the home itself - differs from the others primarily by virtue of the fact that considerably fewer of the pupils from this home are placed in the best speech ability

group, as opposed to those in other divisions, and, on the other hand, more of them than in the other divisions are placed in the second ability group. Those children who make rather a lot of mistakes are not more commonly found here than in the other day-care homes. Moreover, this day-care home contains only ten per cent more children with many speech defects than do the other homes.

The results show that the normal day-care homes also contain many children suffering from both slighter and more severe speech disorders. Furthermore, it should be noted that, in the whole random sample, apart from those children being given regular speech therapy at the Lauttasaari day-care home, there were only two children receiving speech therapy. It must be borne in mind, however, that the study was embarked on and carried out at the beginning of the school term, when several of the day-care homes perhaps had not yet had time to get their speech therapy program under way. There was a greater need for therapy, however, than was being catered for.

3.3. TESTING WITH THE BMA TEST BATTERY AND EVALUATION OF THE TEST ITEMS

In charting the levels of perception, powers of reasoning and spatial orientation ability in pre-school children, I took as my yardstick the BMA test method together with all the test items it includes. Instruction for each test item was exactly the same as that adopted in my battery study of 450 11 to 14

year old schoolchildren. The test master sheet containing all the test items can be seen in Appendix 1.

3.3.1. Auditory tests (V 12 - V 22)

The test item "different sounds" (V 12), "frequency" (V 13), "intensity" (V 14) and "duration of sound" (V 15), like the test items for auditory discrimination, "three small boxes" (V 19) and "diapason etc." (V 20), employed the same scoring system as that used in the earlier investigation. The present study demonstrated that for all items other than that dealing with ability to discriminate duration of sound over 80 or 90 per cent of the pre-school children tested achieved + or ± in the assignments in question. Ability to discriminate duration of sound, on the other hand, clearly proved to be weaker: a mere 50% achieved a corresponding level of success.

This, however, seems quite natural when we consider that the random sample contained a rather high percentage both of actual speech disorder cases and of children who had speech defects to a higher or less degree and, on the other hand, the fact that it is this very defectiveness in discriminating the duration of sound which quite easily gives rise to various linguistic problems. Hence the system of scoring was regarded as suitable in the study of pre-school children, too.

In the items in which auditory perception had to be connected with a visual symbol, 82% of the pre-school children received + or ± for frequency (V 22). On the other hand, in connecting

the different sounds with their visual symbols (V 21), fewer, i.e. 47%, attained a corresponding score.

"Direction of reading" (V 16), noted in connection with the auditory tests, showed that with pre-school children this was established in only exceptional cases. "Direction of reading" was completely unstable with regard to 90 per cent of the test subjects.

As regards repetition of rhythm patterns (V 17) and reading (V 18), a change in the scoring was found necessary in order to render it suitable for pre-school children.

Scoring (V 17):

$$\frac{6 - 5^{1/2}}{6} = ++ \; ; \; \frac{5 - 4^{1/2}}{6} = + \; ; \; \frac{4 - 3^{1/2}}{6} = \pm \; ;$$

$$\frac{3}{6} = \mp \; ; \; \frac{2}{6} = - \; ; \; \frac{1 - 0}{6} = --$$

The former is designed to show that if the test subject was able to give a faultless repetition of all six clap patterns or at least half of them, he scored ++. If he repeated correctly all four clap patterns and half of the five clap patterns, the result was marked down as +, etc.

In following this method of scoring, 20% of the whole sample of pre-school children received at least +, a further 20% $\pm$ and 30% $\mp$, the remaining 30% scoring either - or --.

As regards the reading of rhythm patterns, the following system of scoring was used:

$\frac{6-5}{6}$ = ++ ; $\frac{4}{6}$ = + ; $\frac{3}{6}$ = $\pm$; $\frac{2}{6}$ = $\overline{+}$;

$\frac{1}{6}$ = - ; $\frac{0}{6}$ = --

The reading of rhythm patterns proved more difficult and thus produced more minus scores.

Taking the sample as a whole, 29% of the pre-school children received ++, + or $\pm$; 35% received $\overline{+}$ and the remaining 36% - or --.

3.3.2. Tactual and olfactory discriminating ability

The test items "tactual discriminating ability and the connection of the perception with a visual symbol" (V 23), "visual discriminating ability of different surfaces and the connection of the perception with a visual symbol" (V 24) and "olfactory discriminating ability" (V 25) followed the same basic scoring system as that applied in the investigation of schoolchildren.

Scoring for test items V 23 and V 24 was as follows:
All correct +; confusion of basically similar surfaces, rough and smooth sandpaper, $\pm$; confusion of completely different surfaces -.

Following this system of scoring, 56% of the sample scored +, 31% scored $\pm$ and 13% scored - in the actual item testing

tactual discriminating ability (V 23). For visual discrimination of corresponding surfaces, the result was as follows: + 75%; ± 24% and - 1%.

The pre-school children were less sure of themselves than the schoolchildren in the olfactory discrimination ability tests. This was due particularly to their obviously greater susceptibility to suggestion. (Because one of the yellow liquids had an attractive smell, they also thought the odourless yellow liquid smelled good.)

82% of the sample scored + (39%) or ± (43%). The remainder scored -. In the previous study (of children of school age) the 7 year olds (the CON group) scored 100% (+ = 73%; ± = 27%) in a corresponding context.

3.3.3. Logic and reasoning

Of the tests measuring logic and powers of reasoning, item V 26, "absurd pictures", was scored as follows:
6 pictures correct ++; 5 correct +; 4 correct ±; 3 correct $\overline{+}$; 2 correct - and 1 correct or all wrong --.

Following this system of scoring, the pre-school children obtained the following results:
++ = 13%; + = 20%; ± = 23%; $\overline{+}$ = 29%; - = 13% and -- = 2%.

In the test item "picture series" (V 27) the pre-school children who were able to arrange all three picture series in

the correct logical order (+) comprised 12%. 26% arranged two picture series in the correct order ($\pm$) and 28% arranged one series correctly ($\overline{+}$). About one third of the subjects were unable to arrange any of the picture series in the correct logical order.

3.3.4. Spatial tests

The understanding of spatial relations

In the item "sectors" (V 28) only the $\frac{3}{3}$; $\frac{4}{4}$; $\frac{5}{5}$ and $\frac{6}{6}$ sector devices were used to test the pre-school children. (In testing the schoolchildren, the $\frac{7}{7}$ and $\frac{8}{8}$ sectors were also used.)

If the test subject was able to make all the sector units into complete circles, he scored a + result. If the circle formed from the $\frac{5}{5}$ and $\frac{6}{6}$ sectors were only faulty in that one pair of sectors had been switched - one circle being too "wide", the other too "narrow" - he scored $\pm$. If only the circles composed of the $\frac{3}{3}$ and $\frac{4}{4}$ sectors were faultless, the result was $\overline{+}$. When not even one circle was free from faults, the result was -. When the performance produced an absurd result (i.e. if a sector pointed towards the circumference of the circle), the subject scored --.

Following this system, the performance result for the pre-school children was as follows:

+ = 20%; $\pm$ = 33%; $\overline{+}$ = 28%; - = 12%; -- = 7%.

The scoring system for the "Piéron squares" (V 29) was also adapted for use in the testing of pre-school children. When all five diagrams were cut correctly and combined to form squares, the result was ++. One point was awarded for each correctly executed cutting, and one for correct assembling. A performance result of ++, therefore, indicated a score of 10 points. For the rest, the scoring was as follows:

$$\frac{9-7}{10} = +\ ;\quad \frac{6-4}{10} = \pm\ ;\quad \frac{3-2}{10} = \overline{+}\ ;\quad \frac{1}{10} = -\ ;\quad \frac{0}{10} = --.$$

The subjects' performance was divided, according to the above-mentioned system of scoring, as follows:

++ = 17%; + = 15%; $\pm$ = 17%; $\overline{+}$ = 46%; - = 3%; -- = 2%.

The testing carried out in the test item "semicircles and linear figures" (V 30) showed that it was unnecessary to use more than one model sheet in the testing of pre-school children (a two diagram series).

Scoring:

All two diagram series correct	= ++
1 or 2 faulty diagrams	= +
3 or 4 - " -	= $\pm$
5 or 6 - " -	= $\overline{+}$
7 or 10 - " -	= -
Poorer result	= --

The subjects performance divided into different levels of ability as follows:

++ = 7 %; + = 20%; $\pm$ = 40%; $\mp$ = 25%; - = 8%; -- = 0%.

Tests measuring evaluation and orientation ability

The same basic system of scoring could be followed for almost all tests measuring evaluation and orientation ability as that used in the testing of children of school age.

Test item "classification of colour designs" (V 31), scoring and testees' performance percentages:

All correct = + (12%); two mistakes in the colours or shades of colour = $\pm$ (20%); three mistakes in the colours or shades of colour = $\mp$ (53%); weaker performance = - (15%).

Test item "arrangement of colour designs" (V 32), scoring and testees' performance percentages:

Completely correct = + (75%); one design in the wrong row = $\pm$; designs arranged in two rows totally unrelated to each other = - (5%).

Direction, understanding and spatial positioning for each of the items "bottles and glasses" (V 33) and "pieces of cheese" (V 34) were scored either correct (+) or incorrect (-).

As regards direction, the subjects' performances in both assignments were almost identical:

Direction V 33:

+ 51%; - 49% and V 36 + 55%; - 45%

As regards understanding and spatial positioning, the pieces of cheese picture series clearly proved more difficult. A corresponding situation had also been noted in the former investigation with 7 year old schoolchildren.

Understanding V 34:

+ 61%; - 39% and V 37 + 30%; - 70%

Spatial positioning V 35:

+ 77%; - 23% and V 38 + 30%; - 70%

The same system of scoring could be used for the test items "right-angled triangle" (V 40, V 41) and "equilateral triangle" (V 42, V 43) as that adopted in the testing of children of school age. Scoring and percentage division of the performances of pre-school children were as follows:

Right-angled triangle	V 40	(selection of colours)	+ 49%; ± 3%; - 48%
	V 41	(arrangement)	+ 26%; ± 17%; - 57%
Equilateral triangle	V 42	(selection of colours)	+ 61%; ± 2%; - 37%
	V 43	(arrangement)	+ 18%; ± 25%; - 57%

(+ = all correct; ± = only one or two errors in the selection of colours or an error in spacing; - = colours unrecognized or an error in the shape of the triangle.)

The following system of scoring was adopted for the "mosaic

completion" test item (V 39). If all seven of the part assignments or even five of them were completely correct, the result was ++, and so on as follows:

$\frac{4}{7}$ correct = + ; $\frac{3}{7}$ correct = $\pm$; $\frac{2}{7}$ correct = $\overline{+}$; $\frac{1}{7}$ = -.

Following this system of scoring, the percentage division for the performances of pre-school children was as follows:

++ 9%; + 17%; $\pm$ 29%; $\overline{+}$ 33%; - 12%.

Evaluation and presentation of spatial relations

The former system of scoring was followed for the test items "half sections of faces" (V 44) and "a horse's head" (V 45):

V 44: correct = +; incorrect = -; absurd performance = --.

V 45: correct = +; complete line of profile, but performance partly faulty = $\pm$; profile broken = -; absurd performance = --.

The performances of the pre-school children in the test items in question divided as follows:

V 44: + 59%; - 40%; -- 1%.

V 45: + 39%; $\pm$ 32%; - 29%; -- 0%.

For the profile completion test only the sum variable representing the overall result was included in the table of variables (V 46).

As regards the selection and arrangement of both eyes and ears, points were awarded to each testee on the same basis as that used in the investigation of children of school age:

Selection:

correct choice = + (2); incorrect choice = - (1).

Arrangement:

one eye (or ear) in the correct position = + (3)

If there was only a slight error in placing one eye (or ear), or if two façade eyes (or ears) were well placed on the horizontal axis = $\pm$ (2)

If one or two eyes (or ears) were placed quite wrongly = - (1)

Three eyes or three ears or a completely absurd solution (the last mentioned alternative represents an addition to the scoring system used earlier) = -- (0).

The overall result calculated on the basis of the points obtained was as follows: (brackets indicate division into percentages)

$\frac{10}{10}$ = ++ (20%); $\frac{9}{10}$ = + (7%); $\frac{8 - 7}{10}$ = $\pm$ (33%);

$\frac{6 - 5}{10}$ = $\mp$ (19%); $\frac{4}{10}$ = - (16%); $\frac{3 - 0}{10}$ = -- (5%).

One special aspect is noteworthy, namely, that although, according to the Borel-Maisonny original guidelines, the scoring for 7 year olds and younger children is not so strict in that if they have chosen two façade eyes or ears, placing them well on the horizontal axis, a result of $\pm$ was scored,

there was no need with this sample of 100 pre-school children to adapt the method in question in more than five cases: when the arrangement was correct, usually only one eye or ear had been chosen.

The scoring in the test item "curved lines omitted" (V 47) was adjusted in that a fifth alternative, ± was added to the original +, ± and - scores. The scores for the sample together with percentage division into different levels was as follows:

All correct	= + (15%)
The profile was a continuous line, but the pieces were not arranged in the best possible way	= ± (43%)
The profile was broken, but the pieces followed the basic contour line (vertically for the nose and back of the head, horizontally for the chin and crown of the head)	= ∓ (26%)
The profile was completely broken (the pieces were placed in the reverse position to the basic contour line	= - (9%)
Absurd performance, pieces placed anywhere	= -- (7%).

3.3.5. Motor orientation

The scoring system for the motor orientation test item, "orientation according to a given position" [hands (V 48) and arms (V 49)], was exactly the same as that used in the earlier study. In the overall scores the pre-school children, however, were given one handicap point at the + and ± levels.

Scoring and percentages for the performances were as follows:

V 48

$\frac{12 - 10}{12}$ = + (7%); $\frac{9 - 8}{12}$ = $\pm$ (18%); $\frac{7 - 6}{12}$ = $\mp$ (41%);

$\frac{5 - 4}{12}$ = - (31%); $\frac{3 - 0}{12}$ = -- (3%).

V 49

+ (10%); $\pm$ (31%); $\mp$ (38%); - (19%); -- (2%).

The scoring for the test item, "orientation according to a picture", corresponded exactly to that used in the earlier investigation. Scoring and percentages for the performances were as follows:

Completely correct position	= + (26%)
Almost correct position	= $\pm$ (50%)
Incorrect position	= - (21%)
Situation beyond their powers	= -- (2%)

3.3.6. Laterality

On the basis of handedness, demonstrated through the subjects' use of pen and scissors, and on the basis of the sum of orientation tendencies observed in the test items presupposing the arrangement of picture series (V 27, V 33 and V 36), the test subjects' laterality was regarded as being established (3), unstable (2), contradictory (1) or quite undeveloped (0).

Lateral dominance was regarded as clear when the test subject used his right hand for drawing and cutting and orientated in the picture series always according to the normal reading direction indicated by the picture series or if he was left-handed and orientated systematically as follows:

The sample contained 47% of such cases. Laterality was regarded as unstable when the test subject, in spite of his right or left-handedness, clearly orientated sometimes in a right, sometimes in a left reading direction. Such cases constituted 30% of the sample material.

The laterality was regarded as contradictory when a clearly right-handed subject consistently orientated from right to left or a left-handed subject from left to right. Only 3% of the sample adopted the latter alternative, and it was considered that orientation from right to left could in this case, too, be regarded as a proof of contradictoriness since the normal reading direction (left to right) had not yet been learnt at this age level. 20% of the sample subjects comprised cases of this kind.

The remaining 3% of the subjects consisted of cases whose laterality was quite undeveloped. Sometimes they used the right hand, sometimes the left and orientated sometimes from right to left or then from left to right, now from top to bottom, now from bottom to top.

3.4. THE STATISTICAL METHODS

The following statistical procedures were used in analyzing and interpreting the results of the investigation. The HYLPS program system of the Helsinki University Computing Centre was used in computing all the analyses.

A t-test comparison of the group means of the variables.

↓

The correlations of background variables with the dependent variables and the intercorrelations of the dependent variables by using Pearson's product moment correlation coefficient.

3.5. RESULTS

3.5.1. Comparison of the performances in the different speech ability groups

When comparing the performances of the different speech ability groups in the various test items, one should remember that group I represents children whose speech was more or less free of faults and who constituted the majority of the sample (42%). Thus, in addition to their basic number of points (2), they may have been given one minus point on the grounds of, for example, an 's' fault in their speech. Group II (32%) represents those who made a certain number of speech mistakes

and group III (20%) those who made quite a lot of such mistakes. The lowest level, group IV, represents children whose speech was full of mistakes. The sample contained no cases of serious speech disorders. In fact, the test subjects came from normal day-care homes, only one of which also caters for children suffering from speech defects as well as children who are free from such defects (about half of each).

Tables 1-18 in Appendix 2 show in greater detail mean values and dispersions of the test item performances of the different speech ability groups, together with the significance of the differences in the mean values between group I and the lower groups.

3.5.1.1. Auditory tests

(tables 1-3, variables V 12 - V 22)

As regards the auditory test items, it can be seen that the repetition and reading of rhythm patterns constituted the most sensitive area in this study, too, in which, however, the differences in speech ability are quite slight, as opposed to the earlier study where performances were compared between a control group and various disability groups (Alahuhta 1976_1). Groups II and III as well as group IV were, on the average, clearly weaker than group I in the ability to manipulate auditory and visual units rhythmically.

In the repetition of rhythm patterns (V 17) the difference in the mean values between groups I and II was not, however,

statistically significant (t = 1.30), but for groups I and III the difference in question is statistically significant with a risk level of 1% (t values: I:III = 3.04; I:IV = 3.35).

In the reading of rhythm patterns (V 18) the mean values for the performances of groups II and III differ from those of group I with a risk level of 5%, the result achieved being weaker (t = 2.17 and t = 2.00), and as regards the same variable, the difference in the mean values between groups I and IV is statistically significant with a level of risk of 1% (t = 3.30).

As regards the other auditory test items, there are no statistically significant differences in the performances of the various speech ability groups. However, the performances of group IV were, on the average, clearly poorer than those of group I in the discrimination of different sounds (V 12), frequency of sound (V 13), intensity of sound (V 14) and duration of sound (V 15). The difference in the mean values for the discrimination of duration of sound is statistically almost significant with a level of risk of 5% (t = 2.24).

3.5.1.2. Tactual and olfactory discrimination ability (tables 4-6, variables V 23 - V 27)

As regards tactual and olfactory discrimination ability, there were no statistically significant differences in the average performances of the various speech ability groups.

With regard to olfactory discrimination (V 25), the difference between groups I and III was statistically almost significant with a 5% level of risk (t = 2.10). On the other hand, it can be shown that the performance of group IV was almost equal to that of group I and that the performances of group II differed only slightly from those of group I.

Hence, inferior olfactory discrimination ability does not, on this level of classification, seem to exercise any clear influence on speech ability. The earlier investigation also showed that even if the disability groups as a whole and also the majority of the disability groups separately differed from the control group very significantly in this respect, the mean values for the performances of the articulation group and of the stammerers did not differ from the mean values of the control group more than almost statistically significantly with a 5% level of risk.

3.5.1.3. Logic and reasoning
(tables 4-6, variables V 23 - V 27)

As regards logic and reasoning, there were no statistically significant differences in the average performances of the various speech ability groups. However, the average performance result in both the absurd pictures (V 26) and picture series (V 27) test items was somewhat poorer in the lower ability groups. As regards V 26, the difference in the mean value for group I was the greatest vis-à-vis group III (t = 1.37) and as regards V 27 vis-à-vis group II (t = 1.53).

3.5.1.4. Spatial relations tests

The understanding of spatial relations
(tables 7-9, variables V 28 - V 30)

In the test items measuring the understanding of spatial relations, 'sectors' V 28, 'Piéron squares' V 29 and 'semicircles and linear figures' V 30, the mean values for the performances of the various groups did not differ from each other statistically significantly, although the performances in the lower ability groups were, on the average, poorer than those of speech ability group I. The average performance of group IV, for example, was, as regards all test items, poorer than that of group I, t values being as follows: V 28 - 1.12, V 29 - 1.47 and V 30 - 1.34.

Spatial evaluation and organization
(tables 10-12, variables V 31 - V 43)

Of the test items measuring spatial evaluation and organization ability, the differences in performances can be seen most clearly in just that item ('completion of mosaics' V 39) which all the disability groups in the earlier investigation performed on the average, more poorly than the control group, the difference in the mean values as regards all groups being statistically highly significant with a risk level of 0.1%. The difference was greatest between groups I and IV (t 1.92, p .1) and between groups I and III t = 1.20.

Spatial evaluation and presentation

(tables 13-15, variables V 44 - V 47)

Of the test items belonging to this group, the completion of the profile picture 'face, overall' V 46 and 'curved lines omitted' V 47 proved to be highly discriminating items. Here, too, the trend resembles that of the earlier study quite closely. All the lower speech ability groups carried out their assignments less well than speech ability group I. The difference in mean values between group I and groups II and III was statistically significant with a risk level of 1% (t values for V 46 I:II = 3.35, I:III = 2.97; for V 47 I:II = 2.66, I:III = 2.65).

The average performance for V 46 of members of ability group IV was poorer than that of members of the other groups and for V 47 more or less the same as that of members of group III, but t values, due to greater dispersions, were lower (one of the six members of group IV, whose background of disability lay in directions other than in the weakness of spatial evaluation and presentation, received full points for this item) and the differences only approached statistical significance (t values 1.84 and 1.80; p = .1).

Motor orientation

(tables 16-18, variables V 48 - V 50)

On the average, the lower speech ability groups were weaker than speech ability group I as regards motor orientation. The

performance of group IV was the poorest. In the item 'motor orientation - arms' V 49, the differences in the mean values for groups III and IV in relation to the performance of group I. were statistically almost significant (t values I:III 2.33; p .05 and I:IV 2.23, p .05). As regards the weakest group, the significance of the difference in the mean values in relation to group I also approached statistical significance for V 48 ('motor orientation - hands') and V 50 ('motor orientation according to a picture') (t values 1.99 and 1.80, p = .1).

3.5.2. Comparison of the performances of the observation unit groups formed on the basis of the Apgar score system

The underlying reason for a comparison of the performances of the observation unit groups formed on the basis of the Apgar score system lies in the attempt to discover whether an Apgar score that is lower than normal (8 was the lowest score in this sample) would constitute a predictor of the fact that these children should expect to experience significantly more difficulties in the areas of perception, reasoning and spatial orientation. As a result of the difficulties in question, they would thus perhaps also constitute a kind of risk group in relation to linguistic problems, too, and could thus form a unit group which would seriously merit prophylactic therapy.

Tables 19-30 of Appendix 2 contain the mean values and dispersions of the test item performances of the different groups, together with the significance of the mean value

differences between the group formed on the basis of an Apgar score of eight and the groups formed on the basis of Apgar scores of nine and ten (8APG, 9 APG, 10APG).

3.5.2.1. Auditory tests

(tables 19-20, variables V 12 - V 22)

The average performances of the 8APG group was poorer in the auditory tests than those of the other groups, primarily in the discrimination of different sounds, duration, frequency and intensity of sounds and in the repetition and reading of rhythm patterns. The differences in the mean values between the 8APG group and the 9APG group in the test items 'reading of rhythm patterns' V 18 and 'intensity of sounds' V 14 were statistically significant with a risk level of 1% (t values: 3.36 and 2.93). The corresponding differences between the 8APG and 10APG groups were statistically almost significant with risk levels of 5% and 2% (t values: 2.43 and 2.25).

As regards the ability to discriminate frequency, the significance of the mean value differences between the 8APG and 9APG groups (V 13) is statistically almost significant with a risk level of 5% (t: 2.34) and between the 8APG and 10APG groups (V 22) with a risk level of 2% (t value 2.50).

The results show that those belonging to the 8APG group have had, on the average, poorer, and also statistically significantly or at least almost significantly poorer, potential for the development of correct speech. It can be shown in this

connection that when the average Apgar score for speech ability group I was 9.2, in speech ability group IV it was 8.6. In my view this fact seems to support the above-mentioned conclusion. (The average Apgar score for the whole sample was 9.1.)

3.5.2.2. Tactual and olfactory discrimination ability

3.5.2.3. Logic and reasoning

(tables 21-22, variables V 23 - V 27)

No major differences manifested themselves between the various Apgar groups in tactual and olfactory discrimination ability. On the other hand, in tests presupposing logic and reasoning, V 26 and V 27, the 8APG group's average performance was poorer. The difference in mean values between the 8APG and 10APG groups was statistically almost significant with a risk level of 5% (t values 2.11 and 2.40). The difference in mean values between the 8APG and 9APG groups was almost significant only as regards V 27 (t value 2.17).

3.5.2.4. Spatial relations tests

Understanding of spatial relations

(tables 23-24, variables V 28 - V 30)

The average performance of the 8APG group in the test items 'sectors' (V 28), 'Piéron squares' (V 29) and 'semicircles and linear figures' (V 30) was poorer than those of the other groups. The difference in mean values between the 8APG and 9APG groups was statistically highly significant for V 30 with

a risk level of 0.1%, t being 3.45, and almost significant for V 29 with a 2% level of risk. The difference in mean values approached significance as regards test item V 28, too (t = 1.96).

Spatial evaluation and organization
(tables 25-26, variables V 31 - V 43)

As regards the spatial evaluation and organization tests, the performance of the 8APG group was poorer than those of the other groups in the 'completion of mosaics' test V 39 and in the various part assignments of the picture series, 'bottles and glasses' and 'pieces of cheese'. The difference in mean values of the group's performance of variable V 34 (bottles and glasses - logic) and V 37 (pieces of cheese - logic) and that of the 10APG group was statistically significant with a risk level of 0.1% and for V 39 with a risk level of 5% (t values are 3.29, 3.18, 2.02, respectively). As regards V 39, the difference in mean values between the 8APG and 9APG groups was greater: t = 2.50, p = .02.

Spatial evaluation and presentation
(tables 27-28, variables V 44 - V 47)

The average performance of the 8APG group in all the assignments belonging to this section was poorer than those of the other groups. Compared with the 10APG group, the difference for the test item 'half sections of faces' V 44 was almost significant

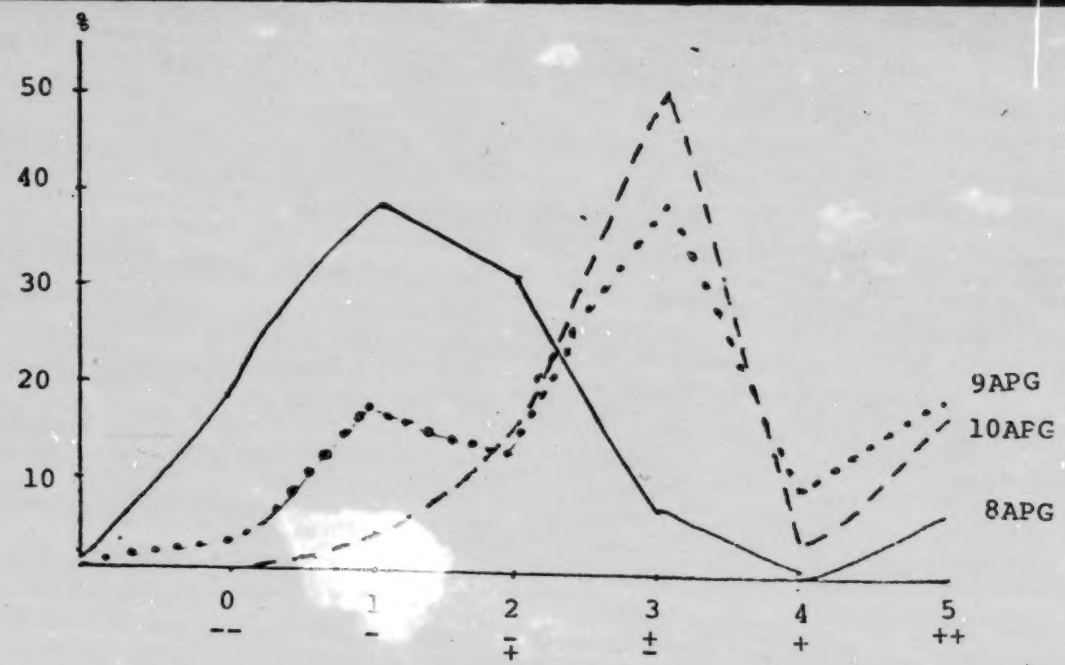

FIGURE 2. Percentage division of the performances of the Apgar groups in test item V 46.

Motor orientation

(tables 29-30, variables V 48 - V 50)

Motor orientation both according to a given position (V 48 and V 49) and according to a picture (V 50) created far greater difficulties for the 8APG group than for the 9APG and 10APG groups.

As regards the orientation of arms, V 49, the difference in mean values in performance between the 8APG and 9APG groups was statistically highly significant with a risk level of 0.1% ($t = 3.44$) and significant between the 8APG and 10APG groups with a 1% level of risk ($t = 2.76$). The corresponding t values for V 50 were as follows: 8APG:9APG, $t = 2.39$, $p = .02$;

8APG:10APG, t = 2.77, p = .01.

Greater difficulties than usual in motor orientation demonstrate that the 8APG group also seemed to have, on the average, a lower potential as regards sound linguistic development compared with the other groups. It is, therefore, with good reason that the question arises of whether these children constitute perhaps a risk group requiring preventative therapy and spatial observation.

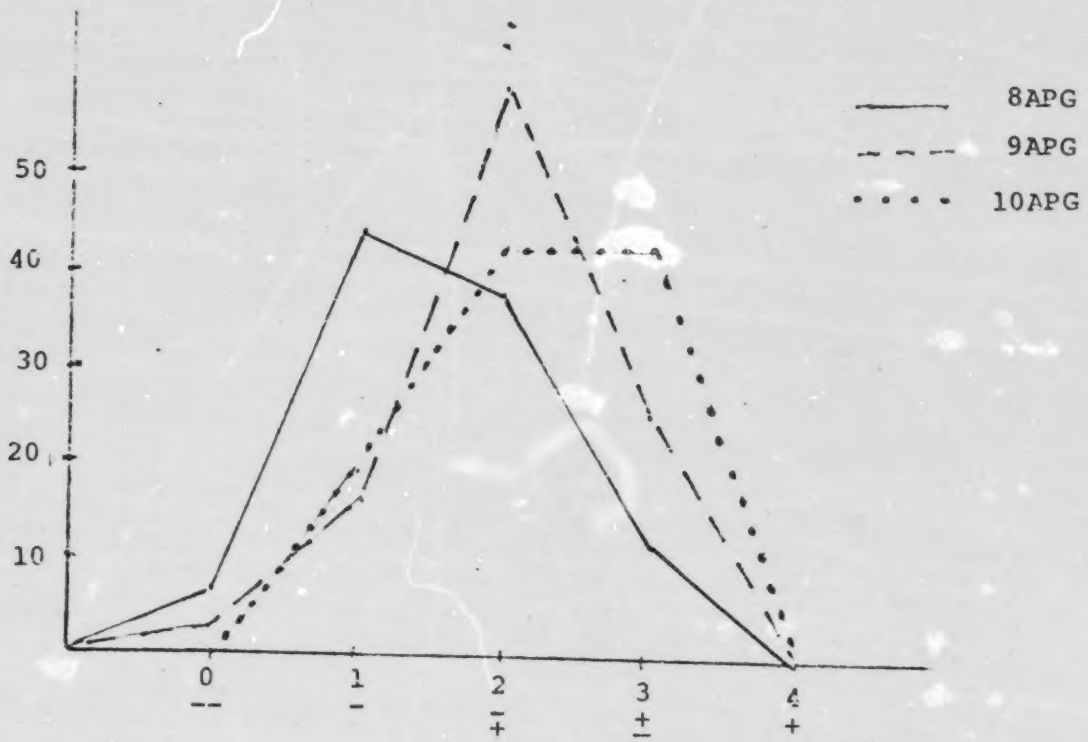

FIGURE 3. Percentage division of the performances of the Apgar groups in test item V 49.

Finally, it is necessary to demonstrate as regards the Apgar groups that the differences in performance of the 9APG and 10APG groups were, on the average, very slight. Statistically significant differences existed only for a few of the test items. The difference in mean values between the groups for the test item 'connection of auditory perception with a visual symbol - sounds' (V 21) was, however, statistically almost significant with a 5% level of risk ($t = 2.31$). More significant differences between the groups in question appeared, however, in the logic picture series 'bottles and glasses' (V 34) and 'pieces of cheese' (V 37): V 34, $t = 2.39$, $p = .02$; V 37, $t = 2.94$, $p = .01$.

3.5.2.5. Speech ability in the different Apgar groups

A comparison of the average Apgar scores in the different speech ability groups shows that the average Apgar score in speech ability group IV was 8.6, as compared with 9.2 in speech ability group I. The average score for the whole sample was 9.1. The difference in mean values between groups I and IV is statistically almost significant with a 5% level of risk ($t = 2.41$).

A parallel examination of the observation unit groups formed on the basis of the Apgar score system, as regards those partial factors on which speech ability is based, gives more detailed information of the disparity between the groups with regard to frequency of errors.

Vocabulary

	correct	errors
10APG	95.8%	4.2%
9APG	92.3%	7.7%
8APG	87.5%	12.5%

Motor production of speech

	fluent	awkward	too fast
10APG	85.5%	12.5%	-
9APG	88.4%	5.8%	5.8%
8APG	75%	25%	-

Articulation

The differences between the groups as regards articulation were considerably greater. Completely clear articulation was to be found in 50% of the 10APG group and in only 12.50% of the 8APG group. 12.50% of the 8APG group also made many mistakes in articulation (4 point mistakes), whereas the 10APG group made no 4 point mistakes.

Figure 4 depicts the mistakes for each group.

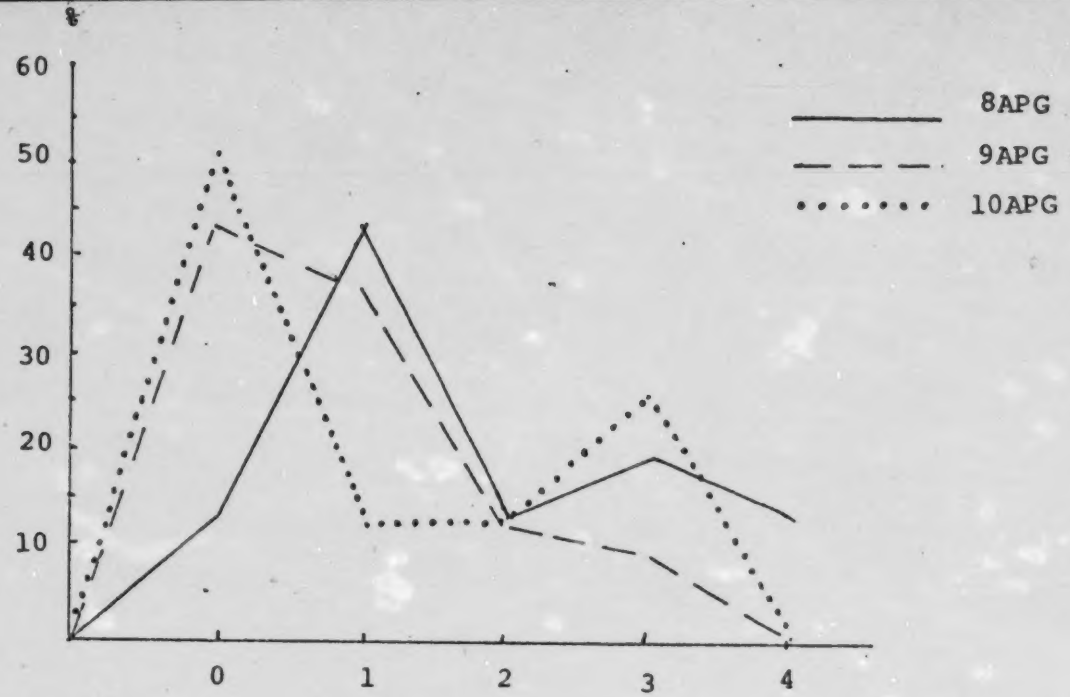

FIGURE 4. Inaccuracies of sound in the different Apgar groups.

0 = no mistakes at all

1 = only the 's' fault

2 = only the 'r' fault

3 = both 's' and 'r' faults

4 = other faults including the 's' and 'r' faults

Word formations

As regards word formations, the performances of the members of the 8APG group contained many more faults than those of the other groups, and even the 9APG group was clearly inferior to the 10APG group in the mastery of word formations. (Figure 5)

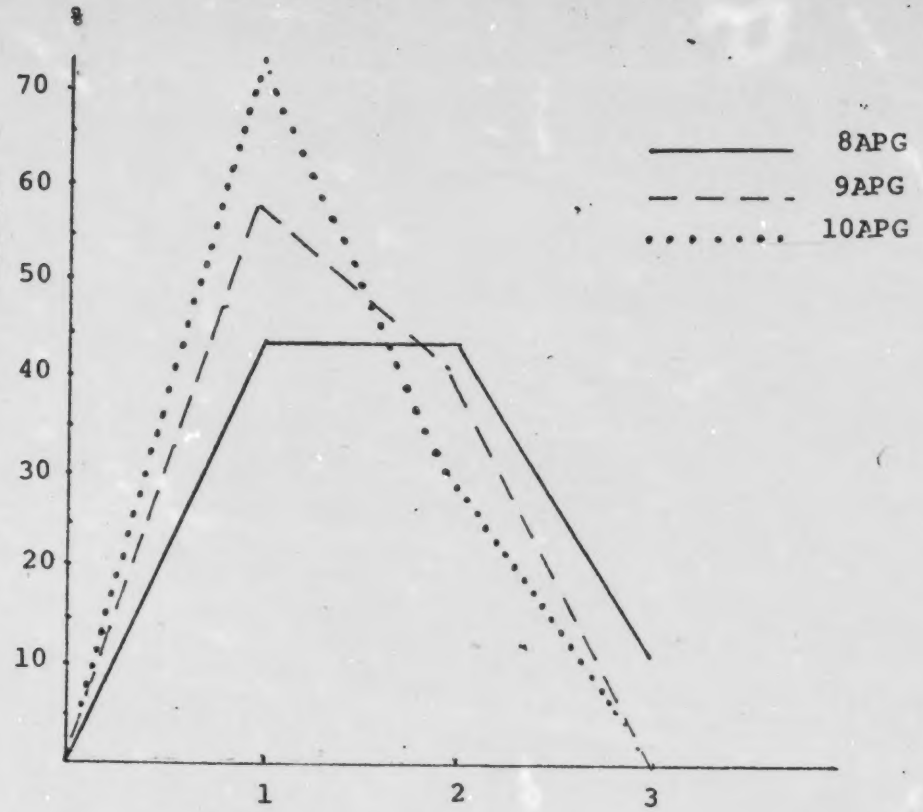

FIGURE 5. Mastery of word formations in the different Apgar groups.

1 = all word formations correct

2 = mistakes with the word traktori

3 = other mistakes as well

Sentence structure

Members of the 8APG group constructed a complete sentence less often than members of the other groups, and constructions representing the lowest level - two words simply placed side by side - were most common among them. (Figure 6)

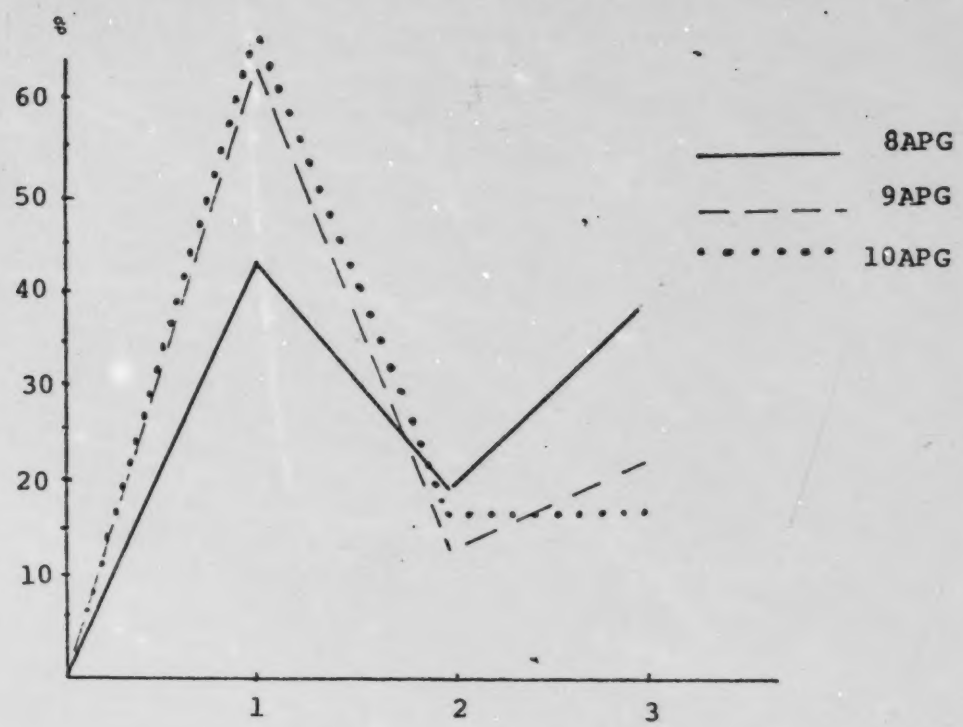

FIGURE 6. Sentence structure ability in the Apgar groups.

The clearest differences between the Apgar groups are to be found, then, in articulation and in the mastery of word formation and sentence structure.

The differences between the groups in speaking abilit as a whole can be seen in figure 7.

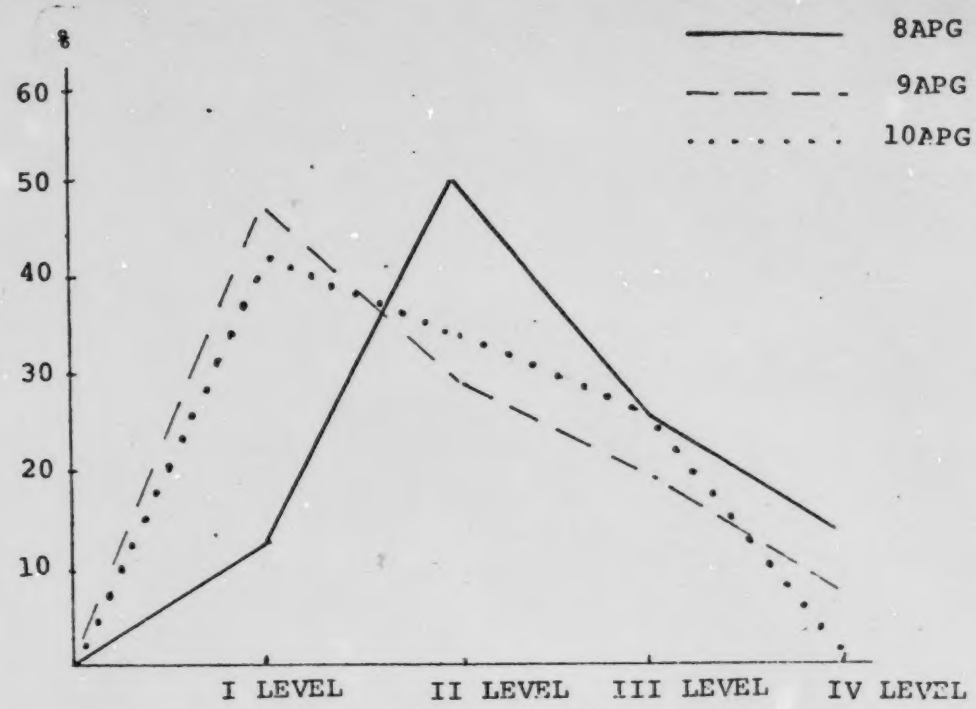

FIGURE 7. Speech ability in the Apgar groups.

3.5.3. Performance of the test items in relation to sex

Sex does not in itself seem to have any appreciable effect on the level of performance of the test items. Actual statistically significant differences did not occur at all, but in many of the test items the average performance was poorer for boys than for girls. The most marked difference occurred in the item 'pieces of cheese' - as regards spatial positioning V 48 ($t = 2.61$, $p = .02$). There were significant differences in the test items 'right-angled triangle - selection of colours' (V 42) and 'motor orientation - according to a picture' (V 50) with a level of risk of 10%.

On the other hand, it should be pointed out that in examining the division of boys and girls into different speech ability groups, the boys accounted for 83.33% of the members of the weakest ability group, IV, and 60% of group III. This should naturally also be taken into consideration when comparing the test item mean values of the performances of the girls and boys as regards those items the performance of which has most clearly been shown to bear a relationship of dependency to speech ability. Of the above-mentioned tests, this relationship of dependency was demonstrated only as regards V 50.

The boys were also clearly weaker than the girls in olfactory discrimination (V 25) ($t = 2.15$, $p = .05$). It has previously been shown that this ability has not revealed any direct relationship of dependency to speech ability.

The division of girls and boys into different speech ability groups again confirmed the result I had arrived at in my earlier study and shared by several other researchers, namely, that boys experienced more linguistic difficulties than girls (Siirala 1969, Bannatyne 1971, Alahuhta 1976_1).

The whole sample contained 51% boys and 49% girls. The division into different speech ability groups, however, was as follows:

TABLE 31. The division of boys and girls into different speech ability groups

	Boys		Girls		Total
	N	%	N	%	
I level	18	42.86	24	57.14	42
II "	16	50	16	50	32
III "	12	60	8	40	20
IV "	5	83.33	1	16.67	6
	51	51	49	49	100

The difference in mean values for speech ability between boys and girls is statistically almost significant with a risk level of 5% (t = 1.99).

3.5.4. A comparison of the subjects' weight at birth, sex and Apgar score

An examination of the test subjects' weight at birth revealed that the average weight for boys was 3500 gr. and for girls 3270 gr. (The difference is statistically significant with a 5% level of risk, t = 1.99.)

The connection between Apgar score and weight at birth has not been shown to be significant.

In the lowest weight group (under 2500 gr.) the mean value for the Apgar score was in fact 8.8, that is three tenths lower than the sample's mean value of 9.1 for the Apgar score, but in the second weight group (2500 gr. - 2750 gr.) it was highest of all at 9.6, and lowest of all at 8.7 in the fourth weight group (3000 gr. - 3200 gr.). The average Apgar score for the heaviest group (over 4500 gr.) was exactly 9.

3.5.5. The dependence on age of the performance of the test items

The subjects were divided according to age into five different observation unit groups. When comparing the performances of

the youngest members of group I (age 5 years 9 months) with those of group V, it can be seen that age can only be regarded as a significant factor of performance ability in three of the test items: orientation, in the assignments 'pieces of cheese' (V 36), 'half sections of faces' (V 44) and 'motor orientation - arms' (V 49). Two of the items (V 36 and V 49) presuppose a quite clearly developed spatial orientation ability, and on the basis of the results it would seem that orientation ability develops particularly strongly during the third quarter of the seventh year of age. The differences in the mean values between the fourth (6 years 6 months) and fifth (6 years 9 months) age groups were statistically significant with a risk level of 1% (V 36: t values I:V = 2.15; IV:V = 2.77; V 49: t values I:V = 2.97; IV:V = 2.93). This does not, however, give an infallible picture of the situation concerning the differences in performance in general between the members of the 4th and 5th age groups.

A comparison of the performances as regards the other test items shows that the average performance of group IV was usually poorer than that of the other groups (this group, comprising those born in the spring, was also the largest group of all - N 29 - as compared with the other groups, which were more or less equal in size, I N 16, II N 19, III N 18, V N 18). In the test item, repetition of rhythm patterns, for example, the performance of which was significantly connected with speech ability, group IV performed more poorly (as they had in V 49) than any other group.

Finally, it can also be seen that age did not seem to have any effect at all on the allocation of children to any speech ability group. There was little difference in the allocation to the various speech ability groups not only of members of the first and fifth but also of members of the fourth age group.

3.5.6. The significance of lateral dominance in the performance of the test items

The test subjects were divided into four different groups according to how they satisfied certain criteria relating to the establishment of lateral dominance (see page 45).
The following discussion compares the performances of those who drew and cut with their right hand and who also invariably orientated from left to right, that is whose cerebral dominance was shown by their performance to be established, with those in whom laterality was unstable or contradictory or in whom it appeared to be quite undeveloped.

The performance of those who were regarded as possessing an established cerebral dominance was to some extent better than that of those with unstable cerebral dominance in the repetition and reading of rhythm patterns and in discovering the mistakes in the absurd pictures and in the logic picture series, 'bottles and glasses' and 'pieces of cheese'. The clearest difference lay in the finding of the spatial position in the former picture series ($t = 2.21$, $p = 0.5$).

The performances of those who were regarded as possessing a contradictory cerebral dominance differed from those of the children with established dominance in more or less the same way as above. The difference lay in the fact that, as regards rhythm manipulation ability, the average performances differed from each other less and that, in addition to the above-mentioned differences, there occurred a clear disparity in the mean values of the performances both in the items, selection of colours in right-angled and equilateral triangles (V 40 and V 42), and in the arrangement of colour pictures into rows according to a given model (V 32). The difference in the last-mentioned was the greatest: $t = 2.31$, $p = .02$.

The difference between the performances of those with established dominance and the performances of those whose cerebral dominance was regarded as being particularly undeveloped was connected, with the exception of V 38, with the other test items as above. Differences in the average performances manifested themselves with regard to these groups in the logic test item, 'picture series' (V 27), in the item dealing with the understanding of spatial relations, 'Piéron squares' (V 29), in the assignment for the understanding of spatial positioning, 'pieces of cheese' (V 38) and in the test items measuring motor orientation, V 48, V 49 and V 50. The greatest difference was to be found in motor orientation - hands (V 48), the difference in the mean values being almost significant with a risk level of 5% ($t = 1.99$).

In examining the part laterality and the level of laterality play in the overall performance of the test items, it can be

seen that even though those children with established cerebral dominance performed certain of the items, on the average, better than the other children, the differences were at most statistically almost significant. In this respect, spatial organization and orientation ability constituted the most sensitive areas.

No connection could be shown between the level of lateral dominance and the subjects' age or Apgar score.

3.5.7. The intercorrelation of the different variables

Of the intercorrelations of the different variables, the correlations between the background variables and the test variables will be dealt with first (tables 32-35).

In an analysis (table 32) of the performance of the whole sample with regard to the dependency of performance of the auditory test items on sex, age, handedness, Apgar score, vocabulary, the motor production of speech, articulation, mastery of word formations, sentence structure ability and speech ability in general, the following conclusions could be drawn:

The strongest relationship of dependency occurred between speech ability and its part factors and the ability to repeat rhythm patterns. The poorer the speech ability was, particularly with regard to articulation and mastery of word formations, the greater was the failure to manage the repetition of rhythm

TABLE 32. Correlations between the variables - dependence of the performance on sex, age, Apgar score, vocabulary, speed of speaking, articulation, word formation, sentence structure and speaking ability as a whole.

Variables		12	13	14	15	16	17	18	19	20	21	22
1	Sex	.009	-.06	.026	-.044	.196	-.073	.005	.142	0	-.030	-.022
2	Age	.060	-.136	.010	-.138	.084	.009	.055	-.078	0	-.107	-.171
4	Handedness	-.020	.106	-.140	-.060	-.062	-.004	.019	-.039	0	.039	-.027
5	Apgar score	.189	.145	.243	-.032	-.020	.143	.178	.105	0	.114	-.009
6	Vocabulary	-.189	-.092	-.175	-.041	-.058	-.183	-.195	.068	0	-.064	.237
7	Speed of speaking	.106	.037	-.064	-.113	-.008	-.137	-.122	-.229	0	-.107	-.224
8	Articulation	-.155	-.193	.102	-.140	-.007	-.371	-.240	-.154	0	.060	.140
9	Word formation	-.015	-.059	-.133	-.045	.051	-.301	-.195	-.154	0	.004	-.120
10	Sentence structure	-.113	-.002	.074	-.046	-.002	-.169	-.280	-.105	0	.051	-.171
11	Speaking ability as a whole	-.139	-.149	-.031	-.196	-.009	-.384	-.311	-.075	0	-.016	-.177

Variables:

12 = Aud.discr. - sounds

13 = Aud.discr. - frequency

14 = Aud.discr. - intensity

15 = Aud.discr. - duration

16 = Direction of reading

17 = Repetition of rhythm patterns

18 = Reading of rhythm patterns

19 = Aud.discrm.: three boxes

20 = Aud.discrm.: diapason etc.

21 = Aud.obs. connected with vis.obs. - sounds

22 = Aud.obs. connected with vis.obs. - frequency

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patterns. The correlation coefficients are .384, .371 and .301, respectively. A parallel relationship of dependency as regards the ability to repeat rhythm patterns could be observed with regard to vocabulary, motor production of speech and sentence structure, but the correlation coefficients were lower than those mentioned above (.183, .137, .169).

The following parallel correlations appeared between the performance of the reading of rhythm patterns and the above-mentioned background variables: speech ability .311, sentence structure .280, articulation .240,vocabulary .195, mastery of word formations .195. As regards the motor production of speech, the relationship of dependency on the performance of the auditory test items was most significant in auditory discrimination V 19 and V 22 (r = .229 and .224). A parallel significant correlation also appeared between speech ability and the ability to discriminate duration of sound (.196).

The strongest correlation between the Apgar score and the performance of the auditory test items was that of ability to discriminate intensity of sound (.243). Auditory discrimination ability was shown to correlate positively with the Apgar score for the other test items, too: different sounds (.189), frequency (.145) and repetition and reading of rhythm patterns (.143, .178).

The correlations of variables 23-32 with the above-mentioned background variables can be seen in table 33. The most significant coefficients recur between the Apgar score and the test items measuring logic and reasoning (V 26, V 27). The

TABLE 33. Correlations between the variables - dependence of the performance on sex, age, Apgar score, vocabulary, speed of speaking, articulation, word formation, sentence structure and speaking ability as a whole.

	Variables	23	24	25	26	27	28	29	30	31	32
1	Sex	.136	.033	-.213	.072	.144	.035	.070	-.028	-.042	.083
2	Age	.006	.092	-.030	.177	.034	.126	.161	.123	.139	.026
4	Handedness	.071	.181	.142	-.038	.160	.124	.013	.021	-.091	.116
5	Apgar score	-.013	.074	-.036	.230	.228	.010	.131	.150	.181	.068
6	Vocabulary	-.037	.092	-.187	-.051	-.194	.072	-.138	-.124	-.100	-.051
7	Speed of speaking	-.012	-.033	-.074	-.098	.006	-.129	-.136	.047	-.097	-.187
8	Articulation	-.024	.096	-.169	-.078	-.119	-.169	-.083	-.127	-.054	.002
9	Word formation	.006	.218	-.051	..020	-.059	-.193	-.142	-.141	-.116	.001
10	Sentence structure	.204	.121	-.070	-.133	-.069	-.193	-.022	-.058	-.097	.049
11	Speaking ability as a whole	.091	.147	-.133	-.129	-.088	-.202	-.076	-.071	-.116	.004

Variables:

23 = Tactual discrm. + connected visual symbol

24 = Vis. disrcm.

25 = Olf. discrm.

26 = Absurd pictures

27 = Log. picture series

28 = Sectors

29 = Piéron

30 = Semicircles and linear figures

31 = Classification of colours

32 = Arrangement of colours

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performances for the assignments, 'absurd pictures' and 'picture series', correlated positively with the Apgar scores (r = .230 and .228).

Furthermore, it appears that the higher the speech ability group to which the subjects have belonged, the better, on the average, their performances of the test item, 'sectors' (V 28) have been. The correlation coefficient -.202 shows a significant relationship of dependency.

Between test items measuring spatial organization and orientation ability and the background variables, the strongest relationship of dependency was that between the Apgar score and logical ability as shown in variables V 34 and V 37 (r = .300 and .330).

The understanding of spatial positioning correlated positively with age in the test item 'bottles and glasses' (V 35), the coefficient being .233.

The poorest performance of the assignment 'completion of mosaics' (V 39) was carried out by those who had particular difficulty with the motor production of speech and with articulation (r = -.269 and .203). The correlation for sentence structure ability was parallel as regards this test item, but the connection with organization ability was even stronger in the item 'equilateral triangle' (V 43), r = -.263.

Of the test items measuring spatial evaluation and presentation ability and motor orientation ability, the Apgar score positively correlated significantly with variables V 46

TABLE 34. Correlations between the variables - dependence of the performance on sex, age, Apgar score, vocabulary, speed of speaking, articulation, word formation, sentence structure and speaking ability as a whole.

Variables		33	34	35	36	37	38	39	40	41	42	43
1	Sex	-.021	.098	-.060	-.062	-.013	-.255	-.119	-.112	-.074	-.173	-.106
2	Age	.115	.070	.233	.170	-.061	-.164	.046	-.011	-.014	.026	.139
4	Handedness	-.133	.010	-.171	-.049	.267	.118	-.066	-.034	.057	-.110	.189
5	Apgar score	.058	.300	.073	.024	.330	.055	.166	.023	.138	.062	.108
6	Vocabulary	-.159	-.060	-.102	-.246	-.032	.055	-.138	-.009	.064	-.080	.101
7	Speed of speaking	.031	-.028	-.071	.016	-.139	-.232	-.269	-.126	-.133	-.004	-.110
8	Articulation	.034	.065	-.086	-.092	.015	-.062	-.203	-.001	.054	.000	-.097
9	Word formation	-.049	-.067	-.005	-.044	-.075	-.178	-.168	.068	-.183	.016	-.263
10	Sentence structure	-.077	-.119	-.134	-.153	-.011	.005	-.152	.003	.000	-.064	-.022
11	Speaking ability as a whole	-.017	.022	-.059	-.144	-.024	-.146	-.183	-.041	-.065	-.050	-.111

Variables:

33 = Bottle + glasses + - direction
34 = - logic
35 = - spatial positioning

36 = Pieces of cheese + - direction
37 = - logic
38 = - spatial positioning

39 = Completion of mosaics

40 = Equil.triangle - selection

41 = Equil.triangle - arrangement

42 = Right-angled triangle - selection

43 = Right-angled triangle - arrangement

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('completion of profile'), V 47 ('curved lines omitted'), V 49 ('motor orientation - arms') and V 50 ('motor orientation according to a picture'). The correlation coefficients were .259, .253, .239 and .278, respectively.

A positive correlation for age can be seen in V 44 (.200), V 46 (.197) and V 49 (.272).

Correct articulation can be connected with good performances in the motor orientation assignments (V 48, V 49 and V 50) and also in the assignments measuring spatial evaluation and presentation ability (V 46, V 47). The correlation coefficients are .233, .338, .217, .239 and .272, respectively.

A parallel connection can also be seen in the performance of these test items, too, as regards the mastery of word formations (V 46 = .334; V 47 = .295; V 49 = .234 and V 50 = .197). As regards speech ability as a whole, there was a parallel correlation for all test items, V 46, V 47 and V 49, more or less equally strongly significant .283 -.282.

The correlations between the test variables can be seen in greater detail in Appendix 5, page 136. We may examine here some of the more significant relationships of dependency. The most clearly discriminating items in the area of auditory discrimination ability, V 17 and V 18, correlate positively first of all with each other, the correlation coefficient being .592. Variable V 17 (the repetition of rhythm patterns) correlates positively with the other test variables in the following order of importance:

TABLE 35. Correlations between the variables - dependence of the performance on sex, age, Apgar score, vocabulary, speed of speaking, articulation, word formation, sentence structure and speaking ability as a whole.

Variables		44	45	46	47	48	49	50	51
1	Sex	.055	-.100	-.159	-.009	-.094	-.092	-.163	-.063
2	Age	.200	-.067	.197	.083	.100	.272	-.010	.076
4	Handedness	-.072	-.038	-.009	.056	-.009	-.050	.164	-.063
5	Apgar score	.201	-.074	.259	.253	.113	.239	.278	-.092
6	Vocabulary	-.046	.009	-.038	.034	-.102	-.096	.000	-.200
7	Speed of speaking	-.057	.039	-.109	-.190	-.101	-.118	-.123	-.114
8	Articulation	-.023	.017	-.239	-.272	-.233	-.338	-.217	.196
9	Word formation	-.245	-.029	-.334	-.295	-.132	-.234	-.197	-.001
10	Sentence structure	-.109	.033	-.216	-.169	.012	-.123	-.099	-.031
11	Speaking ability as a whole	-.025	.040	-.283	-.283	-.190	-.282	-.221	.089

Variables:

44 = Half section of faces

45 = Horse´s head

46 = Face, overall

47 = Curved lines omitted

48 = Motor.orient. - hands

49 = Motor.orient. - arms

50 = Motor.orient. - acc.to the picture

51 = .195 *

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V 14 (.400), V 39 (.349), V 12 (.340), V 46 (.297), V 13 (.267), V 49 (.219), V 15 (.214), V 50 (.212) and V 47 (.200). Variable 18 correlates in a parallel way with the corresponding variables, but the loading of the correlation as regards the different variables was to some extent different: V 39 (.373), V 46 (.302), V 13 (.285), V 15 (.274), V 50 (.263), V 14 (.240), V 47 (.222). Moreover, V 18 correlates positively with V 32, that is the ability to arrange colour pictures according to a given model (.256).

A strong correlation between V 13 and V 22 (.454) shows that when difficulties existed in distinguishing frequencies of sound from each other (V 13), there were also difficulties in connecting the frequencies of different sounds with their visual symbols (V 22).

The degree of logic and reasoning ability in the performance of the absurd pictures correlated positively with the following variables in this order of importance: V 37 (.426), V 28 (.424), V 35 (.303), V 47 (.269), V 48, V 41, V 36 (.264), V 49 (.263), V 40 (.246), V 32 (.235), V 39 (.228).

The positive correlation of variable V 46 with very many of the other variables showed that when the test subjects had had difficulties in performing correctly the task of completing the profile picture, difficulties also often occurred in other areas tested. V 46 correlates significantly with the following test variables: V 38 (.432), V 49 (.401), V 28 (.342), V 30 (.341), V 35 (.337), V 48 (.336), V 44 (.335), V 43 (.317), V 50 (.309), V 18 (.302), V 17 (.297), V 27 (.278).

Variables V 48, V 49 and V 50, representing motor orientation, also correlated positively with each other highly significantly: V 48:V 49, r = .731; V 48:V 50, r = .347; V 49:V 50, r = .413.

The positive correlations between the different variables occurring in connection with the analysis of the correlations of the test variables demonstrate that the results of the present study run parallel with those of the earlier investigation, in which the discriminant analysis showed that 75% of the discrimination between the groups occurred in conditions in which the difference existed in a parallel fashion in the areas of the variables which represented all three factors (Alahuhta 1976_1, p. 82).

3.5.8. An examination of the two sets of triplets

As I have already pointed out in the section 'Subjects', a special opportunity offered itself, in connection with the investigation, of studying two sets of triplets born in 1970. This made possible the analysis of two separate small groups over which neither age nor different socio-cultural factors exercised any influence.

A factor that was common to both sets of triplets was that they each comprised two girls and one boy. Moreover, in both cases the births had been Caesarian sections. A difference did exist in that one of the sections was conducted under a general anaesthetic, the other with a local anaesthetic right up to and including birth.

The latter set of triplets were 5 years and 9 months on the day the testing was carried out, thus representing the youngest age group.

The girls (A and B) had been given an Apgar score of 9 at birth, the boy (C), who was delivered last and was a transverse presentation, scored 8. Weights at birth were A 2460 gr., B 2120 gr. and C 2230 gr. One of the girls, B, scored the best overall result in the tests. She was also placed in the best speech ability group, I. She obtained the best possible score of ++ in the profile completion test item. The other girl, A, who was allocated to speech ability group II, was left-handed and orientated systematically from right to left. She experienced somewhat greater difficulties in the understanding and organization of spatial relations and in auditory discrimination, but she came out best of the three in logic and powers of reasoning.

The boy was placed in speech ability group II and experienced greatest difficulty in the area of spatial evaluation and presentation. In the profile completion assignment, he orientated vertically, in other words, he conformed to the type whose disorders have a neurological background. Moreover, he experienced greater difficulty in the area of auditory discrimination than his sisters, whose only problem was with the discrimination of duration of sound - one sister having more problems than the other.

A feature common to these triplets lay in the fact that the repetition of rhythm patterns came easily to all of them.

The reading of the patterns was relatively poorer for all of them, C's performance being the poorest.

The performance of motor orientation for all of them was poorer than average, although their score did not reach the minus level. Furthermore, it should be borne in mind that motor orientation as regards arms seemed to develop somewhat between the ages of 5 years 9 months and 6 years 9 months, and that the set of triplets in question did, after all, belong to the youngest age group.

Finally, it can be shown that although the triplets were quite evenly matched in the areas of spatial organization and orientation ability and in auditory discrimination, the performance of the boy, who had an Apgar score of 8 points, was the poorest.

The other set of triplets, girl A (10APG), boy B (10APG) and girl C (9APG), belonged to the fourth age group and were 6 years 6 months old at the time the investigation took place.

Both girls were placed in speech ability group I and the boy in group III, primarily on account of his 'r' and 's' sounds. Girl A was clearly the most alert and performed everything well, with the exception of the motor orientation assignments, the Piéron squares and the assignment 'semicircles and linear figures'. Moreover, in spite of being right-handed, she invariably orientated from right to left.

B (the boy) also suffered from contradictory laterality and

accordingly also had difficulties with spatial orientation. Moreover, he experienced considerable difficulties with auditory discrimination. As regards logic and powers of reasoning, he was on a level with A.

Girl C's performance was poorer than that of the others in assignments presupposing logic and powers of reasoning. Moreover, her performance in the motor orientation tests was so weak that it was obvious that in her case the body image was particularly poorly developed. She weighed 2300 gr. at birth and A and B 2500 gr. However, when comparing this set of triplets with that discussed above, there did not seem to be any connection between weight at birth, even when this was very low, and level of performance. Girl B in the former group, whose performance in the tests was, for the most part, very good, weighed only 2120 gr. at birth. Moreover, her motor orientation was also clearly superior, as was that of the whole of the former set of triplets compared with this set.

This latter set, for their part, however, were better at the profile completion test. All performed it with a score of at least $\pm$.

An analysis of both sets of triplets together reveals a common background symptom in those who were allocated to a speech ability group lower than group I, namely, that they were weaker in auditory discrimination than the others. Those placed in ability group III were the weakest. Furthermore, articulation difficulties were quite clearly intensified by weak motor orientation ability. Background symptoms that indicate future

reading and writing disabilities appeared in all six children, but they occurred in a more diversified and accentuated form in the boy (C) and girl (A) of the first-mentioned group and in the boy (B) and one of the girls (C) in the other group. Both members of the former group and the boy from the latter group possess a compensating factor, namely, very good powers of logic and reasoning, reflecting a fairly high intellectual capacity.

3.6. CONCLUSIONS

3.6.1. Examination of the hypothesis

The aim of the present study was to examine the following hypothesis: "Those belonging to the weaker speech ability groups have greater difficulties in perception, powers of reasoning and spatial orientation than those belonging to the better speech ability groups." The investigation confirmed the following proposition: Those belonging to the weaker speech ability groups experience, on the average, greater difficulties particularly in the area of auditory perception and in reasoning and spatial orientation.

As regards auditory perception, the lower speech ability groups were significantly weaker in the rhythmic manipulation of auditory units. In the repetition of rhythm patterns (V 17), the difference in the average performance of group I in relation to the performances of groups III and IV was statistically

significant (t values = 3.04 and 3.35), and even speech ability group II was, on the average, weaker in this respect, even though the difference in mean values between groups I and II was not statistically significant (t value = 1.30). (See figure 8, Appendix 3.)

In the reading of rhythm patterns the difference in performance even between groups I and II was statistically almost significant (t value = 2.17) and the performance of group IV was significantly weaker than that of group I (t value = 3.30). (See fig. 9, Appendix 3.)

Thus, the investigation quite clearly confirmed the findings set out in my thesis, which stated that good rhythmic manipulation, namely, the aptitude to apprehend auditory and visual units rhythmically - to analyze and synthesize them - constitutes one of the basic prerequisites for correct speech development.

The above-mentioned study (Alahuhta 1976) also demonstrated that rhythm manipulation ability in those with reading and writing disabilities was exceptionally poor. So, too, the special problems also experienced by pre-school children in repeating and reading set rhythm patterns could be regarded not only as a primary symptom that reduces the level of their speech, but also as a partial factor indicative of future reading and writing disorders. The significance of the receptivity to rhythm in the development of the spoken and written language has been emphasized by, for instance, Borel-Maisonny (1953, 1967), Brunet (1966), Dedieu-Taillefer

(1966), Dusassou (1969), Sheehan (1970), Patzke (1971), Myklebust (1975) and Aimard (1974).

The performances of the lowest speech ability group were also weakest in the discrimination of frequency and intensity of sound, and the mean difference in the performances for the discrimination of duration of sound was statistically almost significant with a risk level of 5%. (See p. 13, Goldsmit 1976.)

In the discrimination of duration of sound, the average performance of the other groups was poorer than that of members of speech ability group I. (See fig. 10, Appendix 3.)

Borel-Maisonny, who strongly emphasizes the influence of audition and rhythm in linguistic development, has reported in her studies disorders of rhythm particularly in those children whose speech development is retarded, and also in stammerers and those suffering from reading and writing disabilities. Investigations also record that those suffering from dyslexia have three times as great difficulties in the context of rhythm as normal children (Aimard 1974, 309).

As regards auditory perception, it can, therefore, be seen that those pre-school children whose speech contained most mistakes were also poorest equipped for the forming of correct audio-verbal engrams.

Reports on the connection between disorders in auditory discrimination and articulation disorders can be found in

the works of, among others, Carrell 1937, Hall 1938, Kronvall and Diehl 1954, Cohen and Diehl 1963, Prins 1963, Aungst and Frick 1964, Hutschinson and Clark 1968, Haggard-Corrigall-Legy 1971. Various investigations clearly point out the connection between poor reading ability and deficient powers of discrimination of sounds (Monroe 1932, Durell and Murphy 1953, Wepman 1960, Goezünger, Dirks and Baer 1960, Dykstra 1966, Malmqvist 1969, 1970).

The weaker speech ability groups were, on the average, also weaker in assignments presupposing logic and powers of reasoning, but the differences in the mean values were not statistically significant. (See tables 4, 5 and 6.)

The weakest speech ability groups were poorer than group I in spatial orientation both in the visual and in the motor areas. The differences were partly only quantitative, partly statistically significant or at least almost significant.

The earlier study had shown that all those children who were linguistically handicapped in various ways experienced statistically highly significantly ($p = .001$) greater difficulties in performing test items connected with the investigation of the understanding of spatial relations - 'sectors', 'Piéron squares' and 'semicircles and linear figures' (V 28, V 29, V 30). The present study showed that speech ability group IV was also clearly weaker in the above items than group I.

Of the test items associated with spatial evaluation and organization ability, 'completion of mosaics' (V 39) was very sensitive in discriminating between the disability groups in the earlier study, too. The present study also showed that those children whose speech ability was weaker performed the assignments less well than the others. The difference between groups I and IV was statistically almost significant (t = 1.92). (See fig. 11, Appendix 3.)

In both the earlier and present studies, the test items 'face, overall' (V 46) and 'curved lines omitted' (V 47) constituted sensitive discriminating items, and the differences in the mean values for the performances between speech ability group I and the lower groups were, in the present study, either significant or almost significant. (See figures 12 and 13, Appendix 3.)

The above-mentioned difficulties in the area of spatial understanding, organization ability and orientation, which occurred most of all among those pre-school children whose speech was more faulty than that of others, are proof of disturbances in the area of spatial organization and thus also constitute background symptoms of corresponding reading and writing disabilities in the future1.[1)]

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1) When there are difficulties in the context of visual discrimination, they play some part in affecting the develpment of the body image and in the understanding of spatial relations. These disorders make the learning of reading and writing more difficult (Diatkine 1957, Kephart 1960, Gutton 1963, Doman and Delacato 1964, Barsch 1967).

Test items investigating motor orientation also presupposed spatial orientation ability. In the earlier study, a highly significantly weaker performance in these items than that of the control group constituted a discriminating feature common to the disability groups.

The results of the present study also agreed in this respect and, in accordance with the hypothesis, members of the lower speech ability groups were weaker in spatial orientation in the motor area, too. (See figures 14, 15, 16.)

The results further indicate that when somatognosia and kinesthetic ability, which are the prerequisites of a good performance of test items measuring motor orientation ability, are inadequate, the forming of correct pharyngo-buccal proprioceptive engrams is also disturbed. These in their turn are reflected in errors of speech. Since the same background difficulties quite clearly also have an adverse effect on the forming of correct digito-manual proprioceptive engrams in the later process of learning to write, their existence means an additional symptom of impending disabilities in the area of the written language, too.

In my view this comparison of the different speech ability groups among pre-school children strongly supports the concept that therapy of the primary symptoms to be found in the background of speech disorders is necessary, indeed imperative, not only as a promotor of speech ability, but also as a prophylatic measure against disorders in the written language.

3.6.2. Symptomatic value of the Apgar score as a predictive factor of linguistic disorders in the light of the present investigation

One of the aims of the present study was to chart those factors which would be influential in the areas of perception, reasoning and spatial orientation ability in creating those problems which can be regarded as primary symptoms of linguistic disorders. The Apgar score was in this respect of the greatest interest, since experience acquired in earlier practical investigations had justified the conclusion that an Apgar score lower than average could be of symptomatic value as a risk factor in the prediction of linguistic disorders.

The comparative study, in which all the test subjects were divided, according to their Apgar score, into three different observation unit groups - 10APG, 9APG and 8APG - strongly supported this conclusion.

As regards the obvious symptoms, errors of speech, it can be seen that the average Apgar score was lowest in the weakest, i.e. the fourth, speech ability group, and, on the other hand, that those belonging to the 8APG group made a higher percentage of mistakes compared with the other groups in all areas that affected the allocation into speech ability groups in this study. The clearest differences between the Apgar groups occurred in articulation and in the mastery of word formations and sentence structure.

The above-mentioned difference between the average Apgar scores of groups I and IV was statistically almost significant with a 5% level of risk (t = 2.41).

A comparison of the different levels of the Apgar groups as regards perception, reasoning and spatial orientation demonstrated that in those areas measured by the BMA tests which the earlier investigation had shown as disability areas common to speaking, reading and writing disabilities the 8APG group was clearly weaker than the other groups. With regard to some of the test variables, the differences were statistically significant (V 14, V 18, V 34, V 37, V 47, V 50) or even highly significant (V 30, V 46, V 49). Several also revealed almost significant differences (V 13, V 22, V 26, V 27, V 28, V 29, V 35, V 39, V 44, V 48).

In the auditory area the 8APG group differs most clearly from the other groups in the discrimination of intensity and frequency and in the rhythmic understanding of auditory units. (See figs 17-20, Appendix 3.)

Great difficulties in spatial orientation occurred in both the visual and motor areas. (Figs 2 and 3 in the body of the text and 21-25 in Appendix 3.)

The performances of the 8APG group in the profile completion test (V 46) were consistent with the performances of the CP and aphasia groups of the earlier study, to such an extent that they gave good grounds for assuming that the disorders of the members of the 8APG group also had a neurological background.

(See Appendix 4.)[1]

Poor motor orientation ability tells us something of the incomplete development of the body image in members of the 8APG group and shows that articulation faults have been caused in part by faulty pharyngo-buccal proprioceptive engrams, the correct formation of which presupposes accurate somatognosia and kinesthetic ability.[2]

In reviewing the results, attention was aroused particularly by the fact that the 8APG group was also significantly weaker in logic and reasoning (V 34, V 37) and that these tests also revealed a significant difference between the 9APG and 10APG groups, who had hardly differed from each other at all in other respects. (See figs 26 and 27, Appendix 3.) The same trend also appeared in test item V 44, 'half sections of faces', which in the factor analysis of the earlier study was also loaded most strongly on the reasoning factor (see fig. 28, Appendix 3) and in test item V 27, logical organization, in the positioning of the picture series.

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1) In the investigation of powers of visual perception, the understanding of spatial relations and the ability to orientate and organize have excited growing interest and attention, particularly in investigating the problems of CP children and other children suffering from brain damage (Frostig and Maslow 1963, Pollac 1963, Wilke 1963, Birch 1964, Eisenson 1966, Masse 1966, Mecham 1966, Lang 1968, Milhe 1968, Adler 1970, Hartmann 1971).

2) Reports on the connection between the milder forms of brain damage and retardation in speech development, different kinds of speech disorders, dyslexia and dysorthography have been made, among orthers, by Hansen 1965, McWilliams 1965, Creager and van Riper 1967, Pond 1967 and Böhme 1968. McWilliams reports on the different perceptual disorders and the problem of comprehending the "body image" as symptoms in the case in question.

3.6.3. Further conclusions

A comparison of the test results as regards sex again showed that boys experienced greater linguistic difficulties than girls. Sex did not in itself seem to have any effect on the level of performance of the test items.

An examination of the causative connection between established, unstable or contradictory lateral dominance and the level of performance of the test items showed that those with established cerebral dominance performed certain assignments (spatial organization and orientation ability) to some extent better than the others (see p. 45), although the differences were not statistically higher than almost significant.

An attempt was made in the study to clarify as precisely as possible the effect of age on the performance of the test items. The results showed that even though the average performance of pre-school children of certain items was poorer than that of the schoolchildren, to such an extent that it was essential to adapt the scoring, the division of the pre-school children (in this study 5 years 9 months to 6 years 9 months) into five different age groups cannot be regarded as indicating the influence of age in any area other than, to some extent, that of spatial orientation ability.

Finally, it can also be seen that the results arrived at are both interesting and rewarding and provide the researcher with strong motivation for continuing her research, directing her interest primarily in two directions:

1. It would, I think, be very important to conduct a follow-up study with regard to the pre-school sample investigated here, in order to show how their linguistic development progresses, and to what extent they may reveal future reading and writing disabilities. Another aim would also envisage the possibility of a later comparison of the performances of a small therapy group made up from this sample with the performances of those pupils who were not afforded such opportunities for therapy.

2. The results arrived at from a comparison of groups composed according to Apgar score also serve to encourage further research. Because, according to this study, the 8APG group proved to differ quite clearly from the other groups (9APG and 10APG), it would be appropriate to conduct a further investigation to examine the permanence of the results. If these point in the same direction, it would in my view provide a well-based point of departure for regarding children whose Apgar score is eight or lower as a risk group vis-à-vis normal linguistic development and the primary factors which this presupposes, a risk group whose development should be followed with great care and for whom the necessary therapeutic steps should be taken as early as possible.

In my view the investigation also demonstrated that, in spite of the possible different evaluations connected with Apgar scoring and caused by a subjective assessment, it is appropriate to regard the difference between a score of

eight and a score of nine as a watershed, in other words when the symptoms observed are obvious to the extent that, independently of the evaluator, the child most probably obtains an Apgar score of eight or less rather than nine or ten.

Furthermore, a clarification of which of the Apgar scores (1 - 5 - 10 - 15 minutes) given after birth is the most significant in this respect, an improvement to the score in that the time given is always stated in connection with it, would make the scores more useful for the purposes of comparison than they are today.

4. S U M M A R Y

The principal aim in this study of pre-school children was to examine the following hypothesis: Those belonging to the weaker speech ability groups have greater difficulties in perception, powers of reasoning and spatial orientation than those belonging to the better speech ability groups. Members of the sample were also compared as regards sex, age and particularly the Apgar score they received at birth.

An investigation was carried out with a test battery adapted and evaluated by the present writer on the basis of the Suzanne Borel-Maisonny tests (the BMA test). The test material comprised 100 pre-school children (5 years 9 months - 6 years 9 months) from five different day-care homes.

All pre-school children undergoing the tests (70 children) from three day-care homes were tested in succession, and the other two homes provided children (30 in number) who were most readily available for special testing on the test day and whose parents had given permission for their participation in the investigation. The test items of the battery were used to study the test subjects as regards auditory, visual, tactual and olfactory discrimination ability and also with regard to the understanding of spatial relations, orientation and organization ability and logic and powers of reasoning.

The test subjects were divided into four different speech ability groups (I, II, III, IV) according to the following criteria: vocabulary, the motor production of speech, articulation, the mastery of word formations and the ability to construct sentences.

Speech ability group I included those children whose speech, as regards the above-mentioned criteria, was more or less free from faults. Those children were classified in speech ability group II who made some mistakes. Group III comprised those who made rather a lot of mistakes and group IV those whose speech was full of mistakes. The number of point mistakes formed the basis of the classification.

The results showed that the weakest speech ability groups were, as regards all abilities referred to in the hypothesis, weaker, on the average, than speech ability group I. Statistically significant differences occurred in rhythm manipulation ability and in the area of spatial evaluation and presentation ($p = 0.1$). The differences in motor orientation ability were statistically almost significant ($p = 0.5$).

Moreover, it appeared that those children whose Apgar score was 8 experienced significantly ($p = 0.1$), sometimes even highly significantly ($p = 0.01$) more difficulties in several areas of perception, in logic and reasoning and in spatial orientation than those whose Apgar score was 9 or 10.

Of the above, mention may be made particularly of rhythm manipulation and motor orientation ability.

It could also be seen that, whereas the average Apgar score of members of speech ability group I was 9.2, that of group IV was 8.6. The difference is statistically almost significant with a risk level of 5% ($t = 2.41$).

The test battery, which I had already used in the study of children of school age (Alahu[illegible]a 1976) also proved useful in charting the primary symptoms of speech, reading and writing disorders in pre-school children.

T I I V I S T E L M Ä

Tämän esikouluikäisten keskuudessa suoritetun tutkimuksen ensisijaisena tarkoituksena oli tarkistaa asetettu oletta-mus: heikoimpiin puhetasoryhmiin kuuluvilla on enemmän vai-keuksia havaitsemisen, päättelykyvyn ja avaruudellisen suun-tautumisen alueella kuin parhaimpiin puhetasoryhmiin kuulu-villa. Otoksen vertailua suoritettiin myös mm. sukupuolen, iän ja erityisesti syntymän jälkeen annettujen Apgar-pistei-den suhteen.

Tutkimus suoritettiin Suzanne Borel-Maisonnyn testeistä muokkaamallani ja vaakaamallani osiopatteristolla (BMA-testillä). Tutkittavina oli yhteensä 100 esikouluikäistä (5 v 9 kk - 6 v 9 kk) viidestä eri päiväkodista. Kolmesta päiväkodista tutkittiin järjestään kaikki tutkittavissa ole-vat esikouluikäiset (70 lasta) ja kahdesta muusta ne, jotka tutkimuspäivinä olivat helpoimmin irroitettavissa erityis-tutkimukseen, ja joiden vanhemmat olivat antaneet suostu-muksensa tutkimuksen suorittamiseen (30 lasta). Testipat-teriston osioilla tutkittiin koehenkilöiden auditiivista, visuaalista, taktiilista ja olfaktorista diskriminointikykyä, edelleen avaruudellista tajuamista, orientoitumista ja jä-sentelykykyä sekä loogisuutta ja päättelykykyä.

Koehenkilöt jaettiin neljään eri puhetasoryhmään (I, II, III ja IV) seuraavien kriteerien perusteella: sanavarasto, puheen motorinen tuotto, artikulointi, sanahahmojen hallinta ja lauserakenteen taso. I puhetasoryhmään kuuluivat ne, joiden puhe mainittujen kriteerien suhteen oli jokseenkin virheetöntä. II puhetasoryhmään luokittuivat ne, joilla oli jonkin verran virheitä, III:een ne, joilla oli jo melko paljon virheitä ja alimpaan IV puhetasoon ne, joilla oli puheessaan runsaasti virheitä. Luokittelun perusteena oli virhepisteiden lukumäärä.

Tulokset osoittivat, että heikoimmat puhetasoryhmät olivat kaikkien asetetussa olettamuksessa nimettyjen kykyjen suhteen keskimääräisesti huonompia kuin ensimmäinen puhetasoryhmä. Tilastollisesti merkitseviä eroja esiintyi rytmillisessä manipulointikyvyssä sekä avaruudellisen arvioinnin ja esittämisen alueella ($p = 0.1$). Motorisessa orientoitumiskyvyssä olivat erot tilastollisesti lähes merkitseviä ($p = 0.5$).

Lisäksi ilmeni, että niillä lapsilla, jotka kuuluivat 8APG-ryhmään oli merkitsevästi ($p = 0.1$), osin jopa erittäin merkitsevästi ($p = 0.01$), enemmän vaikeuksia useilla havaitsemisen alueilla, loogisuudessa ja päättelykyvyssä sekä avaruudellisessa orientoitumisessa kuin niillä, joiden Apgar-piste oli 9 tai 10. Edellämainituista nimettäköön erityisesti rytmillinen manipulointi- ja motorinen orientoitumiskyky.

Osoittautui lisäksi, että kun I:n puhetasoryhmän keskimääräinen Apgar-piste oli 9.2, oli se IV:ssä puhetasoryhmässä 8.6. Ero on tilastollisesti lähes merkitsevä 5 %:n riskitasolla (t = 2.41).

Testipatteristo, jota käytin jo kouluikäisiä koskevassa tutkimuksessa (Alahuhta 1976), osoittautui hyödylliseksi myös esikouluikäisten lasten puhe-, luku- ja kirjoitushäiriöiden primaarioireiden kartoittajana.

R E S U M E

Le but principal de cette étude effectuée chez des enfants d'âge préscolaire a été l'examen de l'hypothèse suivante: les enfants appartenant à des groupes présentant les plus faibles aptitudes à parler ont de plus grandes difficultés de perception, de raisonnement et d'orientation spatiale que ceux des groupes possédant les meilleures aptitudes à parler. D'autre part, des comparaisons ont été établies entre les sujets en ce qui concerne le sexe, l'âge, et en particulier le nombre de points Apgar attribués à la naissance.

L'examen, effectué à l'aide d'une batterie-test à éléments adaptée et évaluée par l'auteur du présent document d'après les tests (BMA) de Suzanne Borel-Maisonny, concernait 100 enfants d'âge préscolaire (5 ans 9 mois - 6 ans 9 mois) dans cinq garderies différentes.

Tous les enfants provenant de trois de ces garderies (70 sujets) ont été examinés successivement, alors que les sujets fournis par les deux autres établissements (30 au total) étaient ceux qui se trouvaient le plus facilement disponibles le jour même du test et dont les parents avaient donné la permission de les soumettre à un examen spécial. Les enfants ont été examinés à l'aide des éléments de la batterie quant à leurs facultés de discrimination auditives, visuelles, tactiles et olfactives, ainsi que leur compréhension des relations

spatiales, leurs facultés d'orientation et d'organisation et leur puissance de logique et de raisonnement.

Les sujets ont été répartis en quatre groupes (I, II, III, IV) correspondant à leurs aptitudes à parler et basés sur les critères suivants: vocabulaire, production motrice de la parole, articulation, maîtrise des formations de mots et aptitude à la construction des phrases.

Le groupe I comprenait les enfants dont le langage, pour ce qui est des critères précités, était plus ou moins exempt de fautes; le groupe II les enfants faisant quelques fautes; le groupe III ceux faisant plusieurs fautes; et le groupe IV ceux faisant de très nombreuses fautes. Cette classification a été basée sur le nombre de points-fautes attribués au sujet.

Les résultats ont montré que les groupes présentant les plus faibles aptitudes à parler étaient, pour toutes les facultés énoncées dans notre hypothèse, en moyenne plus faibles que le groupe I. Des différences importantes au point de vue statistiques sont apparues dans les facultés de manipulation rythmique et dans la zone d'évaluation et de présentation spatiales ($p = 0.1$). Les différences dans les facultés d'orientation motrice étaient, du point de vue statistiques, assez importantes ($p = 0.5$).

De plus, il est apparu que les enfants dotés de 8 points Apgar présentaient d'une manière significative ($p = 0.1$), et parfois même hautement significative ($p = 0.01$), plus de difficultés dans plusieurs zones de perception, dans la logique

et le raisonnement, ainsi que dans l'orientation spatiale, que ceux totalisant 9 ou 10 points Apgar. Il faut à cet égard mentionner plus particulièrement les facultés de manipulation rythmique et d'orientation motrice.

On a, par ailleurs, pu constater que le nombre moyen de points Apgar des sujets figurant au groupe I atteignait 9.2, alors que celui du groupe IV était de 8.6. Au point de vue statistiques la différence est assez importante, avec un risque de 5 % ($t = 2.41$).

La batterie test que j'avais déjà utilisée dans mes recherches chez les enfants d'âge scolaire (Alahuhta 1976) s'est également révélée utile pour l'enregistrement des premiers symptômes des troubles de la parole, de la lecture et de l'écriture chez les enfants d'âge préscolaire.

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BMA-TESTS STUDY SHEET

(A test battery based on the Borel-Maisonny tests and adapted and evaluated by Eila Alahuhta)

Name: . Age:

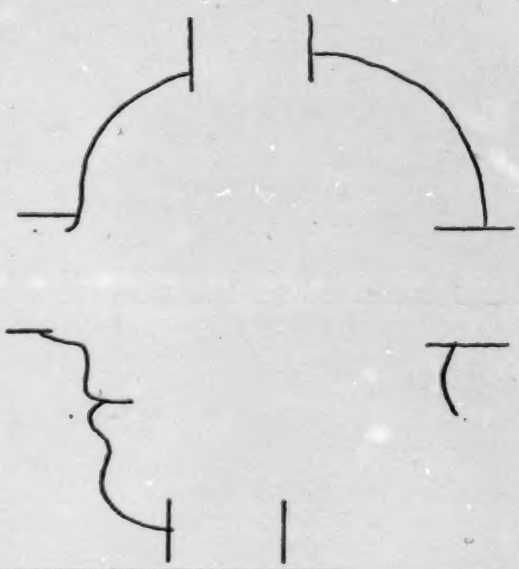
Type of disorder:

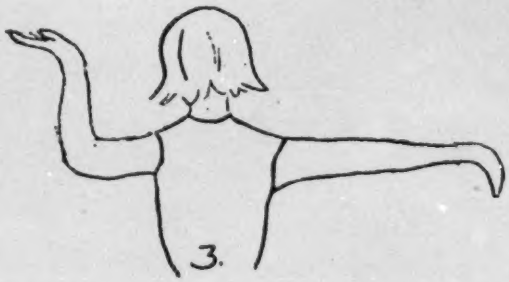
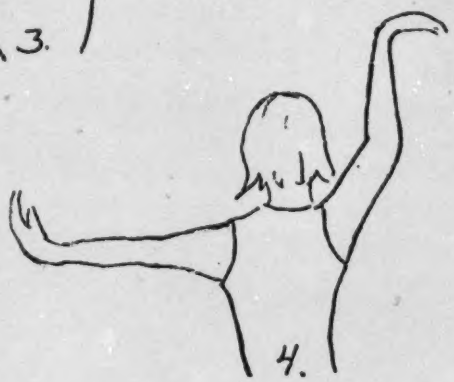
Handedness:

		+	+ —	— +	—	— —
1	AUDITORY DISCRIMINATION direction					
2	Resonator sounds					
3	frequency					
4	intensity					
	duration					
5	Reading direction total					
6	Rhythm: — repetition of claps					
7	— finding of corresponding faces					
8	Three small boxes: - discrimination					
9	Diapason etc. - discrimination					
	THE CONNECTION OF AUDITORY OBSERVATION WITH VISUAL SYMBOLS:					
10	Diapason etc. — sounds					
11	— frequency					
	TACTUAL DISCRIMINATION AND THE CONNECTION OF TACTUAL PERCEPTION WITH VISUAL SYMBOLS:					
12	— tactual discrimination					
13	— visual - " -					
14	OLFACTORY DISCRIMINATION: — bottles containing different odours					
15	LOGIC: —absurd pictures 1. 2. 3. 4. 5. 6. 7. TOTAL ___/7					
16	— picture series: 1. 2. 3. TOTAL ___/3					
	direction:					
	SPATIAL RELATIONS TESTS:					
17	a) auditory tests — sectors 3 4 — + — ; 5 6 — + — ; 7 8 — + — (3 4; 5 6; 7 8)					
18	—Pieron's squares: cutting 1. 2. 3. 4. 5. assembling					
19	— semicircles and linear figures 2 marks; 3 marks; 4 marks; 5 marks					

		+	+ / − −	− / +	−	− −
	b) evaluation and orientation ability					
20	— classification of colours, shades					
21	arrangement					
22	— bottle and glasses					
23	direction					
24	logic / spatial positioning					
25	— cheese direction					
26	logic					
27	spatial positioning					
28	— completion of mosaics					
	(1.) 2. 3. 4. 5. 6. 7. 8. TOTAL ___/7					
	— marble board					
	equil. triangle					
29	selection					
30	arrangement					
	right-angled triangle					
31	selection					
32	arrangement					

	+	+ −	− +	−	− −
c) evaluation and presentation of spatial relations					
3 — half sections of faces					
4 — a horse's head					
— profile completion					
5 eyes: selection					
6 arrangement					
7 ears: selection					
8 arrangement					
9 TOTAL:					
10 — completion of the broken profile contours					



		+	+ −	− +	−	−−
	d) motor orientation — according to the position given					
	hands					
	1.					
	2.					
	3.					
	4.					
						
	arms					
	1.					
	2.					
	3.					
	4.					
						
	TOTAL:					
41	hands					
42	arms					
43	- on the basis of the picture					

— Alahuhta 75.

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TABLE 1. Comparison of the performances of speech ability groups I and II - auditory tests

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
12	Sound discrm.	42	2.83	0.49	32	2.84	0.37	72	0.10	
13	Frequency discrm.	42	2.48	0.63	32	2.34	0.79	72	0.80	
14	Intensity discrm.	42	2.69	0.64	32	2.81	0.54	72	0.87	
15	Duration discrm.	42	1.69	0.75	32	1.66	0.74	72	0.20	
16	Reading direction	42	1.05	0.31	32	1.13	0.49	72	0.83	
17	Repetition of rhythm patterns	42	3.60	1.23	32	3.22	1.24	72	1.30	
18	Reading of rhythm patterns	42	3.10	1.27	32	2.41	1.46	72	2.17	.05
19	Three small boxes	42	1.98	0.15	32	1.94	0.25	72	0.83	
20	Diapason etc.	42	2.00	0.00	32	2.00	0.00	72	0.00	
21	Aud.obs. & its visual symbols - sounds	42	1.60	0.77	32	1.72	0.85	72	0.65	
22	Aud.obs. & its visual symbols - frequency	42	2.36	0.79	32	2.47	0.62	72	0.66	

TABLE 2. Comparison of the performances of speech ability groups I and III - auditory tests

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
12	Sound discrm.	42	2.83	0.49	20	2.75	0.55	60	0.60	
13	Frequency discrm.	42	2.48	0.63	20	2.22	0.89	60	1.40	
14	Intensity discrm.	42	2.69	0.64	20	2.80	0.52	60	0.66	
15	Duration discrm.	42	1.69	0.75	20	1.50	0.69	60	0.96	
16	Reading direction	42	1.05	0.31	20	1.05	0.22	60	0.03	
17	Repetition of rhythm patterns	42	3.60	1.23	20	2.60	1.14	60	3.04	.01
18	Reading of rhythm patterns	42	3.10	1.27	20	2.40	1.05	60	2.00	.05
19	Three small boxes	42	1.98	0.15	20	1.90	0.31	60	1.30	
20	Diapason etc.	42	2.00	0.00	20	2.00	0.00	60	0.00	
21	Aud.obs. & its visual symbols - sounds	42	1.60	0.77	20	1.80	0.77	60	0.98	
22	Aud.obs. & its visual symbols - frequency	42	2.36	0.79	20	2.20	0.83	60	0.64	

TABLE 3. Comparison of the performances of speech ability groups I and IV - auditory tests

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
12	Sound discrm.	42	2.83	0.49	6	2.50	0.55	46	1.54	
13	Frequency discrm.	42	2.48	0.63	6	2.17	0.93	46	1.40	
14	Intensity discrm.	42	2.69	0.64	6	2.33	0.82	46	1.23	
15	Duration discrm.	42	1.69	0.75	6	1.00	0.00	46.	2.24	.05
16	Reading direction	42	1.05	0.31	6	1.00	0.00	46	0.37	
17	Repetition of rhythm patterns	42	3.60	1.23	6	1.83	0.98	46	3.35	.01
18	Reading of rhythm patterns	42	3.10	1.27	6	1.33	0.85	46	3.30	.01
19	Three small boxes	42	1.98	0.15	6	2.00	0.00	46	0.37	
20	Diapason etc.	42	2.00	0.00	6	2.00	0.00	46	0.00	
21	Aud.obs. & its visual symbol - sounds	42	1.60	0.77	6	1.50	0.84	46	0.28	
22	Aud.obs. & its visual symbol - frequency	42	2.36	0.79	6	1.83	0.98	46	1.47	

TABLE 4. Comparison of the performances of speech ability groups I and II - tactual and olfactory discrimination, logic and reasoning

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
23	Tactual discrm. + associated symbol	42	2.43	0.70	32	2.41	0.67	72	0.14	
24	Visual discrm. + associated symbol	42	2.69	0.52	32	2.69	0.47	72	0.03	
25	Olfact. discrm.	42	2.31	0.72	32	2.25	0.72	72	0.35	
26	Log.+reasoning - absurd pictures	42	3.00	1.36	32	2.91	1.23	72	0.31	
27	- " - - picture series	42	2.33	1.00	32	1.97	1.03	72	1.53	

TABLE 5. Comparison of the performances of speech ability groups I and III - tactual and olfactory discrimination, logic and reasoning

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
23	Tactual discrm. + associated symbol	42	2.43	0.70	20	2.55	0.69	60	0.64	
24	Visual discrm. + associated symbol	42	2.69	0.52	20	2.80	0.41	60	0.83	
25	Olfact. discrm.	42	2.31	0.72	20	1.90	0.72	60	2.10	.05
26	Log.+reasoning - absurd pictures	42	3.00	1.36	20	2.50	1.32	60	1.37	
27	- " - - picture series	42	2.33	1.00	20	2.20	1.11	60	0.47	

TABLE 6. Comparison of the performances of speech ability groups I and IV - tactual and olfactory discrimination, logic and reasoning

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
23	Tactual discrm.+ associated symbol	42	2.43	0.70	6	2.67	0.52	46	0.80	
24	Visual discrm.+ associated symbol	42	2.69	0.52	6	3.00	0.00	46	1.45	
25	Olfact. discrm.	42	2.31	0.72	6	2.33	0.82	46	0.08	
26	Log.+reasoning - absurd pictures	42	3.00	1.36	6	2.67	1.37	46	0.56	
27	- " - - picture series	42	2.33	1.00	6	2.00	0.89	46	0.77	

TABLE 7. Comparison of the performances of speech ability groups I and II - spatial perception

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
28	Sectors	42	2.71	1.15	32	2.44	1.16	72	1.02	
29	Piéron	42	2.83	1.38	32	2.10	1.17	72	0.84	
30	Semicircles and linear figures	42	3.00	0.86	32	2.86	1.19	72	0.53	

TABLE 8. Comparison of the performances of speech ability groups I and III - spatial perception

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
28	Sectors	42	2.71	1.15	32	2.10	1.17	60	1.95	.1
29	Piéron	42	2.83	1.38	32	2.85	1.50	60	0.04	
30	Semicircles and linear figures	42	3.00	0.86	32	3.00	1.17	60	0.00	

TABLE 9. Comparison of the performances of speech ability groups I and IV - spatial perception

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
28	Sectors	42	2.71	1.15	6	2.17	0.75	46	1.12	
29	Piéron	42	2.83	1.38	6	2.00	0.00	46	1.47	
30	Semicircles and linear figures	42	3.00	0.86	6	2.50	0.84	46	1.34	

TABLE 10. Comparison of the performances of speech ability groups I and II - spatial evaluation and organization ability

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
31	Classification of colours	42	2.33	0.98	32	2.41	0.76	72	0.35	
32	Arrangement of colours	42	3.76	0.58	32	3.59	0.62	72	1.21	
33	Bottle+glasses - direction	42	1.50	0.51	32	1.56	0.50	72	0.53	
34	Bottle+glasses - logic	42	1.60	0.50	32	1.56	0.50	72	0.28	
35	Bottle+glasses - spatial positioning	42	1.81	0.40	32	1.70	0.47	72	0.61	
36	Pieces of cheese - direction	42	1.60	0.50	32	1.53	0.51	72	0.54	
37	Pieces of cheese - logic	42	1.31	0.47	32	1.28	0.46	72	0.33	
38	Pieces of cheese - spatial positioning	42	1.38	0.49	32	1.25	0.44	72	1.19	
39	Completion of mosaics	42	2.91	1.08	32	2.91	1.23	72	0.01	
40	Right-angled triangle - selection	42	2.12	0.99	32	1.91	0.99	72	0.91	
41	Right-angled triangle - arrangement	42	1.79	0.90	32	1.66	0.87	72	0.26	
42	Equil.triangle - selection	42	2.31	0.95	32	2.22	0.98	72	0.40	
43	- " - - arrangement	42	1.69	0.81	32	1.59	0.80	72	0.73	

TABLE 11. Comparison of the performances of speech ability groups I and III - spatial evaluation and organization ability

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
31	Classification of colours	42	2.33	0.98	20	2.10	0.85	60	0.91	
32	Arrangement of colours	42	3.76	0.58	20	3.85	0.37	60	0.62	
33	Bottle+glasses - direction	42	1.50	0.51	20	1.55	0.51	60	0.36	
34	Bottle+glasses - logic	42	1.60	0.50	20	1.56	0.50	60	0.79	
35	Bottle+glasses - spatial positioning	42	1.81	0.40	20	1.70	0.47	60	0.96	
36	Pieces of cheese - direction	42	1.60	0.50	20	1.55	0.51	60	0.26	
37	Pieces of cheese - logic	42	1.31	0.47	20	1.35	0.49	60	0.31	
38	Pieces of cheese - spatial positioning	42	1.38	0.49	20	1.15	0.39	60	1.87	.1
39	Completion of mosaics	42	2.91	1.08	20	2.55	1.10	60	1.20	
40	Right-angled triangle - selection	42	2.12	0.99	20	2.05	1.00	60	0.62	
41	Right-angled triangle - arrangement	42	1.79	0.90	20	1.45	0.76	60	1.44	
42	Equil.triangle - selection	42	2.31	0.95	20	2.30	0.98	60	0.67	
43	- " - - arrangement	42	1.69	0.81	20	1.55	0.69	60	1.01	

TABLE 12. Comparison of the performances of speech ability groups I and IV - spatial evaluation and organization ability

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
31	Classification of colours	42	2.33	0.98	6	2.00	0.00	46	0.63	
32	Arrangement of colours	42	3.76	0.58	6	3.68	0.52	46	0.38	
33	Bottle+glasses - direction	42	1.50	0.51	6	1.33	0.52	46	0.75	
34	Bottle+glasses - logic	42	1.60	0.50	6	1.50	0.55	46	0.43	
35	Bottle+glasses - spatial positioning	42	1.81	0.40	6	1.83	0.41	46	0.14	
36	Pieces of cheese - direction	42	1.60	0.50	6	1.17	0.41	46	2.01	.05
37	Pieces of cheese - logic	42	1.31	0.47	6	1.17	0.41	46	0.71	
38	Pieces of cheese - spatial positioning	42	1.38	0.49	6	1.33	0.52	46	0.22	
39	Completion of mosaics	42	2.91	1.08	6	2.00	1.10	46	1.92	.1
40	Right-angled triangle - selection	42	2.12	0.99	6	2.00	1.10	46	0.27	
41	Right-angled triangle - arrangement	42	1.79	0.90	6	2.00	0.90	46	0.55	
42	Equil.triangle - selection	42	2.31	0.95	6	2.00	1.10	46	0.73	
43	- " - - arrangement	42	1.69	0.81	6	1.33	0.82	46	1.01	

TABLE 13. Comparison of the performances of speech ability groups I and II - spatial evaluation and presentation

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
44	Half sections of faces	42	1.56	0.54	32	1.56	0.50	72	0.26	
45	Horse's head	42	2.07	0.81	32	2.06	0.84	72	0.05	
46	Face, overall	42	3.41	1.27	32	2.34	1.45	72	3.35	.01
47	Curved lines omitted	42	2.91	0.91	32	2.25	0.98	72	2.66	.01

TABLE 14. Comparison of the performances of speech ability groups I and III - spatial evaluation and presentation

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
44	Half sections of faces	42	1.56	0.54	20	1.60	0.50	60	0.03	
45	Horse's head	42	2.07	0.81	20	2.25	0.79	60	0.82	
46	Face, overall	42	3.41	1.27	20	2.45	1.43	60	2.97	.01
47	Curved lines omitted	42	2.91	0.91	20	2.15	1.31	60	2.65	.01

TABLE 15. Comparison of the performances of speech ability groups I and IV - spatial evaluation and presentation

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
44	Half sections of faces	42	1.56	0.54	6	1.50	0.55	46	0.40	
45	Horse's head	42	2.07	0.81	6	2.00	1.10	46	0.19	
46	Face, overall	42	3.41	1.27	6	2.33	1.75	46	1.84	.1
47	Curved lines omitted	42	2.91	0.91	6	2.17	1.17	46	1.80	.1

TABLE 16. Comparison of the performances of speech ability groups I and II - motor orientation

	Variables	I group			II group					
		N	M	D	N	M	D	df	t	p
48	Motor orient. - hands	42	2.12	0.92	32	1.91	0.93	72	0.98	
49	Motor orient. - arms	42	2.52	0.89	32	2.34	0.91	72	0.86	
50	Motor orient. - acc. to picture	42	2.14	0.81	32	2.00	0.67	72	0.81	

TABLE 17. Comparison of the performances of speech ability groups I and III - motor orientation

	Variables	I group			III group					
		N	M	D	N	M	D	df	t	p
48	Motor orient. - hands	42	2.12	0.92	20	1.85	0.40	60	1.03	
49	Motor orient. - arms	42	2.52	0.89	20	1.95	0.95	60	2.33	.05
50	Motor orient. - acc. to picture	42	2.14	0.81	21	1.85	0.59	60	1.44	

TABLE 18. Comparison of the performances of speech ability groups I and IV - motor orientation

	Variables	I group			IV group					
		N	M	D	N	M	D	df	t	p
48	Motor orient. - hands	42	2.12	0.92	6	1.33	0.82	46	1.99	.1
49	Motor orient. - arms	42	2.52	0.89	6	1.67	0.82	46	2.23	.05
50	Motor orient. - acc. to picture	42	2.14	0.81	6	1.50	0.84	46	1.80	.1

TABLE 19. Comparison of the performances of the groups with 8 and 9 Apgar score - auditory tests

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
12	Sound discrim.	16	2.56	0.73	52	2.85	0.42	66	1.97	.1
13	Frequency discrm.	16	2.00	0.89	52	2.50	0.70	66	2.34	.05
14	Intensity discrm.	16	2.31	0.87	52	2.83	0.51	66	2.93	.01
15	Duration discrm.	16	1.50	0.63	52	1.62	0.77	66	0.54	
16	Reading direction	16	1.00	0.00	52	1.10	0.41	66	0.94	
17	Repetition of rhythm patterns	16	2.81	1.64	52	3.35	1.20	66	1.42	
18	Reading of rhythm patterns	16	1.69	1.08	52	2.91	1.32	66	3.36	.01
19	Three small boxes	16	1.88	0.34	52	1.96	0.19	66	1.28	
20	Diapason etc.	16	2.00	0.00	52	2.00	0.00	66	0.00	
21	Aud.obs. & its visual symbols - sounds	16	1.75	0.86	52	1.52	0.73	66	1.06	
22	Aud.obs. & its visual symbols - frequency	16	2.00	0.89	52	2.33	0.78	66	1.41	

TABLE 20. Comparison of the performances of the groups with 8 and 10 Apgar score - auditory tests

	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
12	Sound discrm.	16	2.56	0.73	24	2.88	0.34	38	1.84	.1
13	Frequency discrm.	16	2.00	0.89	24	2.42	0.72	38	1.63	
14	Intensity discrm.	16	2.31	0.87	24	2.83	0.48	38	2.43	.02
15	Duration discrm.	16	1.50	0.63	24	1.46	0.59	38	0.21	
16	Reading direction	16	1.00	0.00	24	1.00	0.00	38	0.00	
17	Repetition of rhythm patterns	16	2.81	1.64	24	3.25	1.29	38	0.94	
18	Reading of rhythm patterns	16	1.69	1.08	24	2.63	1.41	38	2.25	0.5
19	Three small boxes	16	1.88	0.34	24	1.96	0.20	38	0.97	
20	Diapason etc.	16	2.00	0.00	24	2.00	0.00	38	0.00	
21	Aud.obs. & its visual symbols - sounds	16	1.75	0.86	24	1.96	0.86	38	0.75	
22	Aud.obs. & its. visual symbols - frequency	16	2.00	0.89	24	2.58	0.58	38	2.50	0.2

TABLE 21. Comparison of the performances of the groups with 8 and 9 APGAR score - tactual and olfactory discrimination, logic and reasoning

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
23	Tactual discrm.+ associated symbol	16	2.38	0.81	52	2.50	0.61	66	0.66	
24	Visual discrm.+ associated symbol	16	2.63	0.62	52	2.75	0.44	66	0.90	
25	Olfact. discrm.	16	2.19	0.75	52	2.25	0.74	66	0.30	
26	Log.+reasoning - absurd pictures	16	2.31	1.59	52	2.71	1.19	66	1.08	
27	- " - - picture series	16	1.63	0.81	52	2.23	1.02	66	2.17	.05

TABLE 22. Comparison of the performances of the groups with 8 and 10 APGAR score - tactual and olfactory discrimination, logic and reasoning

	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
23	Tactual discrm.+ associated symbol	16	2.38	0.81	24	2.38	0.77	38	0.00	
24	Visual discrm.+ associated symbol	16	2.63	0.62	24	2.75	0.44	38	0.75	
25	Olfact. discrm.	16	2.19	0.75	24	2.13	0.74	38	0.26	
26	Log.+reasoning - absurd pictures	16	2.31	1.59	24	3.25	1.23	38	2.11	.05
27	- " - - picture series	16	1.63	0.81	24	2.42	1.14	38	2.40	.05

TABLE 23. Comparison of the performances of the groups with 8 and 9 APGAR score - spatial perception

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
28	Sectors	16	2.00	1.27	52	2.65	1.14	66	1.96	.1
29	Piéron	16	2.19	1.33	52	3.12	1.38	66	2.39	.02
30	Semicircles and linear figures	16	2.19	1.17	52	3.19	0.97	66	3.45	.001

TABLE 24. Comparison of the performances of the groups with 8 and 10 APGAR score - spatial perception

	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
28	Sectors	16	2.00	1.27	24	2.17	1.05	38	0.45	
29	Piéron	16	2.19	1.33	24	2.89	1.12	38	1.77	.1
30	Semicircles and linear figures	16	2.19	1.17	24	2.83	0.87	38	2.01	.05

TABLE 25. Comparison of the performances of the groups with 8 and 9 APGAR score - spatial evaluation and organization ability

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
31	Classification of colours	16	2.00	0.73	52	2.29	0.85	66	1.23	
32	Arrangement of colours	16	3.69	0.48	52	3.67	0.62	66	0.09	
33	Bottle+glasses - direction	16	1.50	0.52	52	1.50	0.51	66	0.00	
34	Bottle+glasses - logic	16	1.38	0.50	52	1.56	0.50	66	1.28	
35	Bottle+glasses - spatial positioning	16	1.56	0.51	52	1.85	0.36	66	2.46	.02
36	Pieces of cheese - direction	16	1.56	0.51	52	1.50	0.51	66	0.43	
37	Pieces of cheese - logic	16	1.13	0.34	52	1.25	0.44	66	1.05	
38	Pieces of cheese - spatial positioning	16	1.19	0.40	52	1.35	0.48	66	1.20	
39	Completion of mosaics	16	2.13	1.03	52	2.94	1.18	66	2.50	.02
40	Right-angled triangle - selection	16	2.00	1.03	52	2.10	0.93	66	0.34	
41	Right-angled triangle - arrangement	16	1.50	0.82	52	1.67	0.83	66	0.73	
42	Equil.triangle - selection	16	2.13	1.06	52	2.31	0.94	66	0.67	
43	- " - - arrangement	16	1.36	0.72	52	1.64	0.74	66	1.23	

TABLE 26. Comparison of the performances of the groups with 8 and 10 APGAR score - spatial evaluation and organization ability

	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
31	Classification of colours	16	2.00	0.73	24	2.50	0.93	38	1.80	.1
32	Arrangement of colours	16	3.69	0.48	24	3.80	0.51	38	0.65	
33	Bottle+glasses - direction	16	1.50	0.52	24	1.58	0.50	38	0.51	
34	Bottle+glasses - logic	16	1.38	0.50	24	1.83	0.38	38	3.29	.01
35	Bottle+glasses - spatial positioning	16	1.56	0.51	24	1.71	0.46	38	0.93	
36	Pieces of cheese - direction	16	1.56	0.51	24	1.58	0.50	38	0.13	
37	Pieces of cheese - logic	16	1.13	0.34	24	1.58	0.50	38	3.18	.01
38	Pieces of cheese - spatial positioning	16	1.19	0.40	24	1.29	0.46	38	0.13	
39	Completion of mosaics	16	2.13	1.03	24	2.83	1.13	38	2.02	.05
40	Right-angled triangle - selection	16	2.00	1.03	24	2.08	1.02	38	0.25	
41	Right-angled triangle - arrangement	16	1.50	0.82	24	1.88	0.95	38	1.29	
42	Equil.triangle - selection	16	2.13	1.06	24	2.33	0.96	38	0.65	
43	- " - - arrangement	16	1.36	0.72	24	1.67	0.82	38	1.16	

TABLE 27. Comparison of the performances of the groups with 8 and 9 APGAR score - spatial evaluation and presentation

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
44	Half sections of faces	16	1.38	0.50	52	1.56	0.54	66	1.20	
45	Horse's head	16	2.31	0.79	52	2.04	0.84	66	1.16	
46	Face, overall	16	1.50	1.27	52	2.94	1.39	66	3.74	.001
47	Curved lines omitted	16	1.94	1.00	52	2.52	1.13	66	1.85	.1

TABLE 28. Comparison of the performances of the groups with 8 and 10 APGAR score - spatial evaluation and presentation

	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
44	Half sections of faces	16	1.38	0.50	24	1.56	0.54	38	2.16	.05
45	Horse's head	16	2.31	0.79	24	2.08	0.83	38	0.87	
46	Face, overall	16	1.50	1.27	24	2.88	1.26	38	3.37	.01
47	Curved lines omitted	16	1.94	1.00	24	2.83	0.92	38	2.92	.01

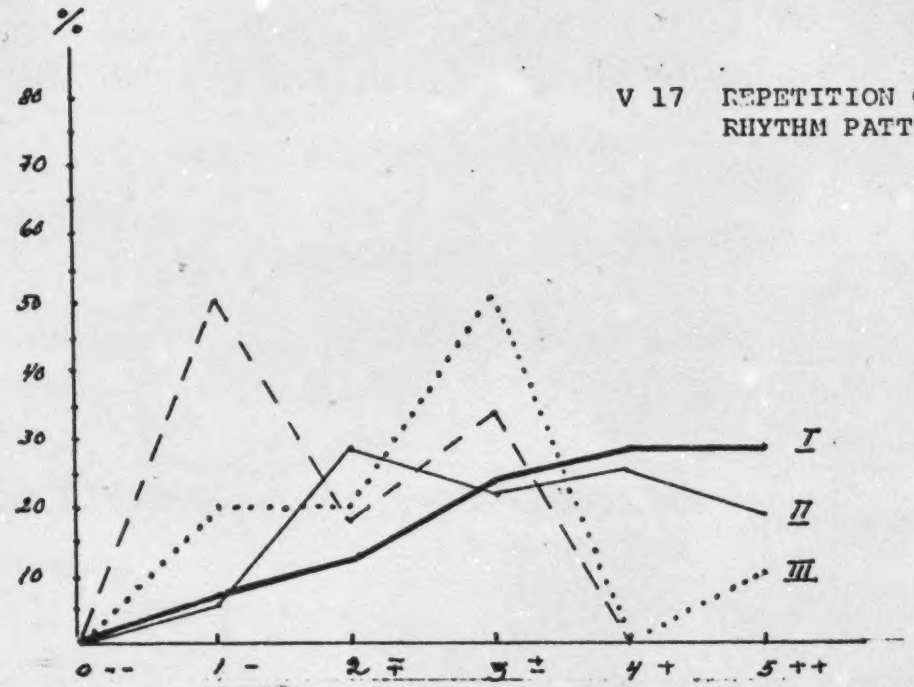
TABLE 29. Comparison of the performances of the groups with 8 and 9 APGAR score - motor orientation

	Variables	8 Apgar points			9 Apgar points					
		N	M	D	N	M	D	df	t	p
48	Motor orient. - hands	16	1.50	1.03	52	2.04	0.93	66	1.98	.05
49	Motor orient. - arms	16	1.56	0.89	52	2.44	0.90	66	3.44	.001
50	Motor orient. - acc. to picture	16	1.56	0.81	52	2.06	0.70	66	2.39	.02

TABLE 30. Comparison of the performances of the groups with 8 and 10 APGAR score - motor orientation

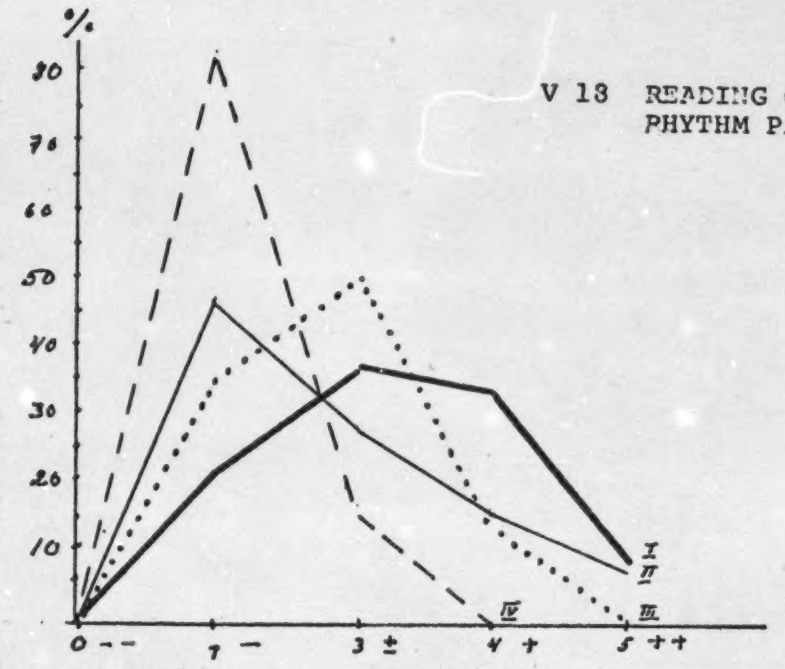
	Variables	8 Apgar points			10 Apgar points					
		N	M	D	N	M	D	df	t	p
48	Motor orient. - hands	16	1.50	1.03	24	1.92	0.83	38	1.41	
49	Motor orient. - arms	16	1.56	0.89	24	2.38	0.92	38	2.76	.01
50	Motor orient. - acc. to picture	16	1.56	0.81	24	2.25	0.74	38	2.77	.01

APPENDIX 3 a



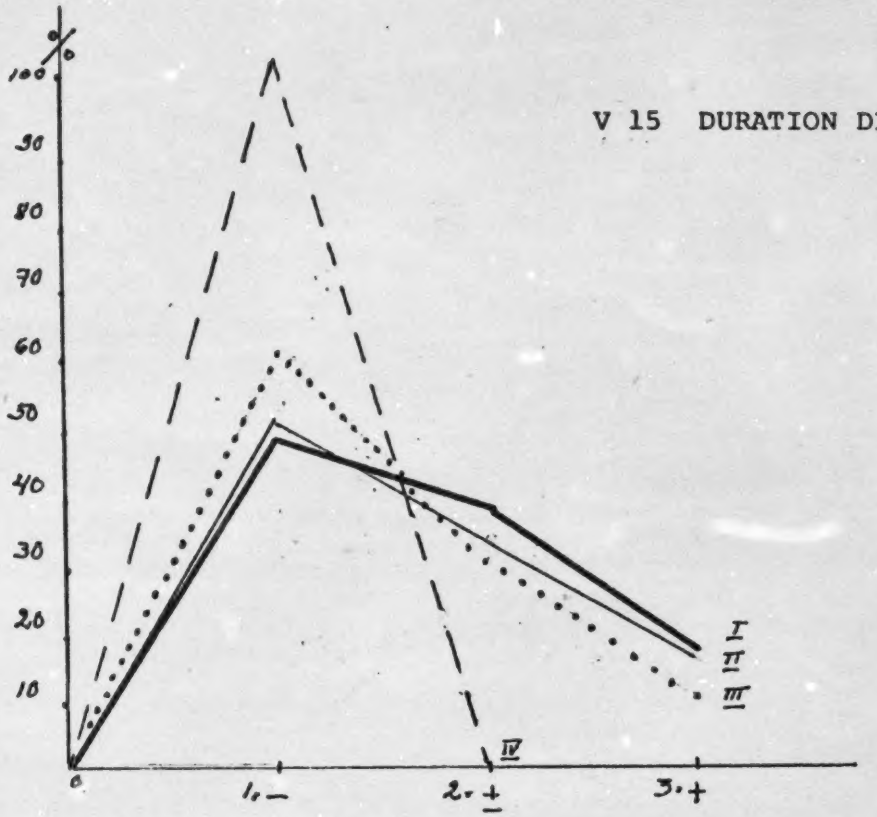
V 17 REPETITION OF RHYTHM PATTERNS

FIGURE 8



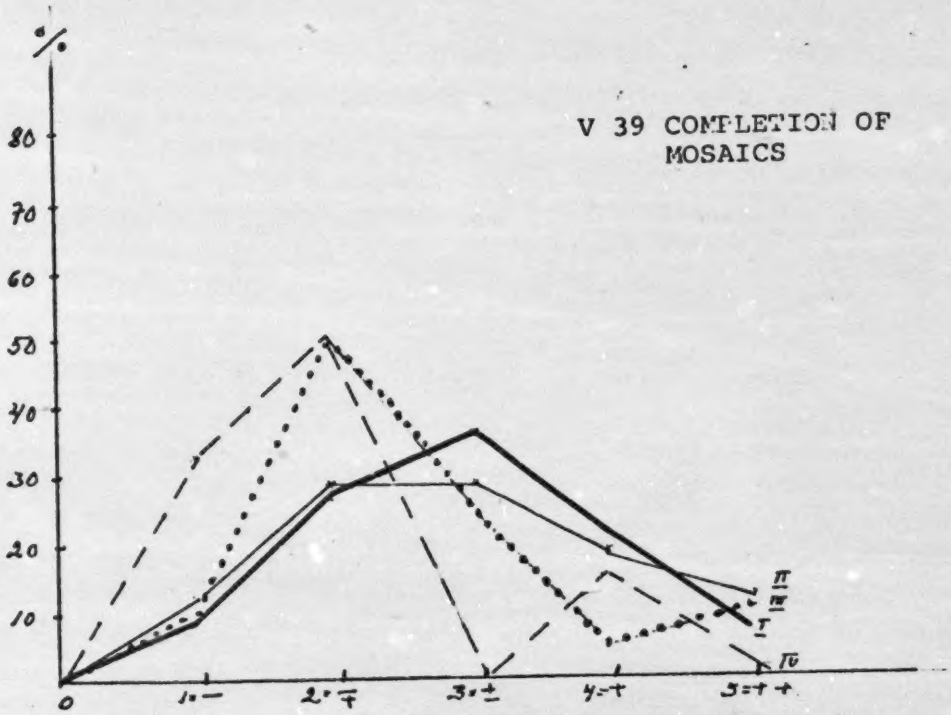
V 18 READING OF PHYTHM PATTERNS

FIGURE 9



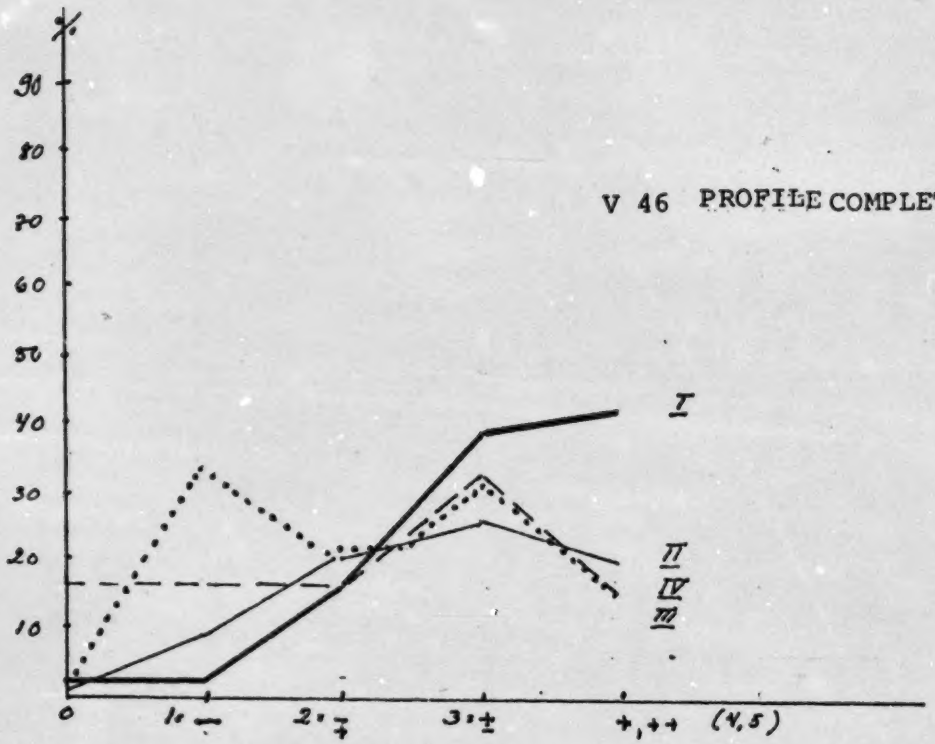
V 15 DURATION DISCRM.

FIGURE 10



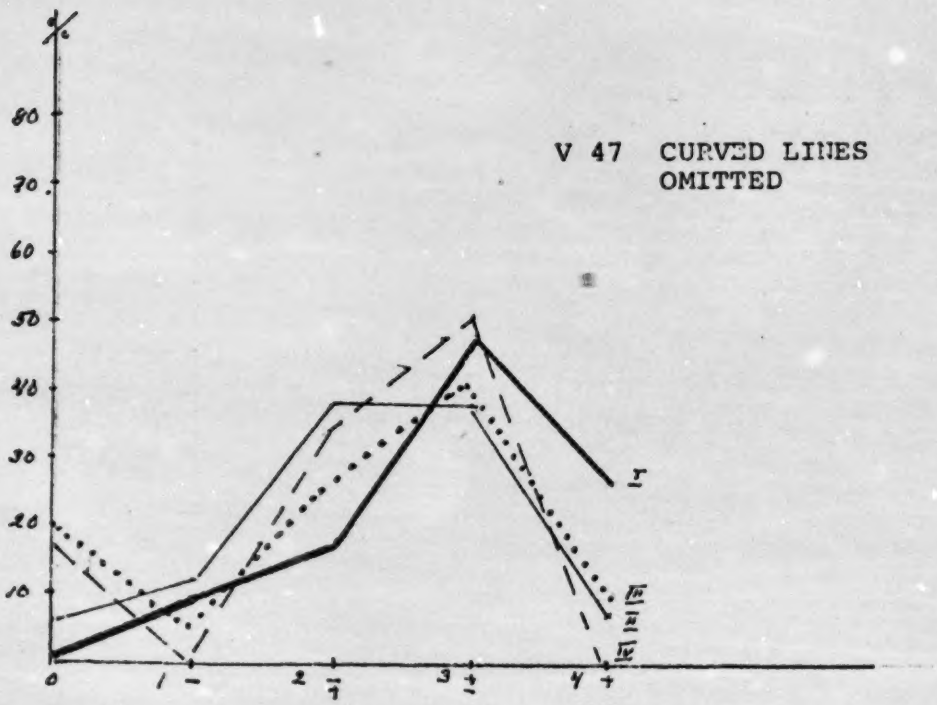
V 39 COMPLETION OF MOSAICS

FIGURE 11



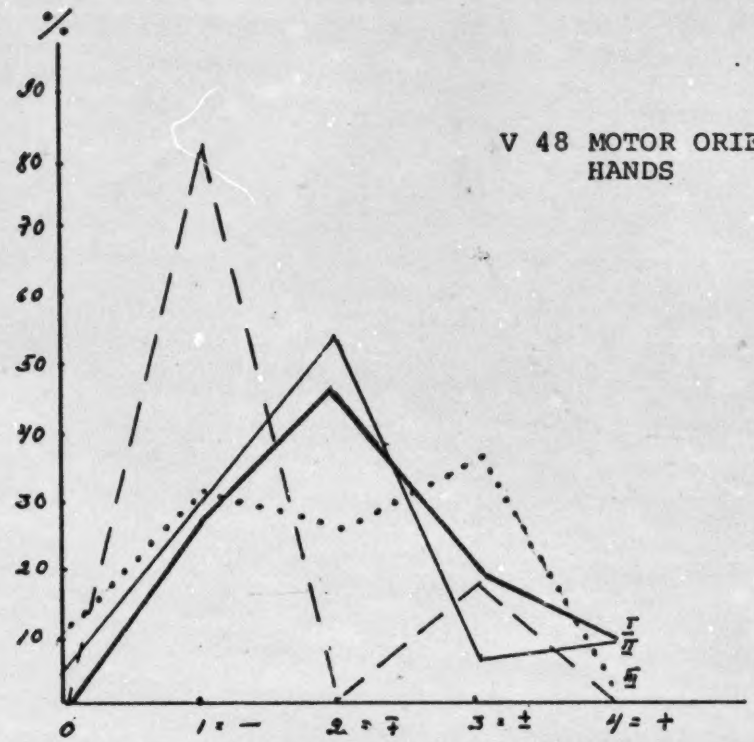
V 46 PROFILE COMPLETION

FIGURE 12



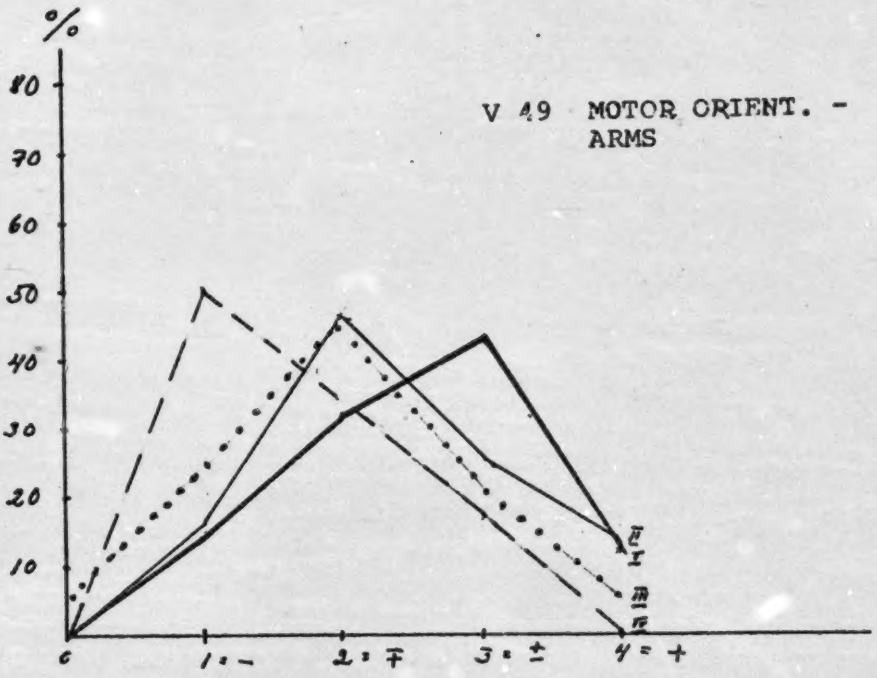
V 47 CURVED LINES OMITTED

FIGURE 13



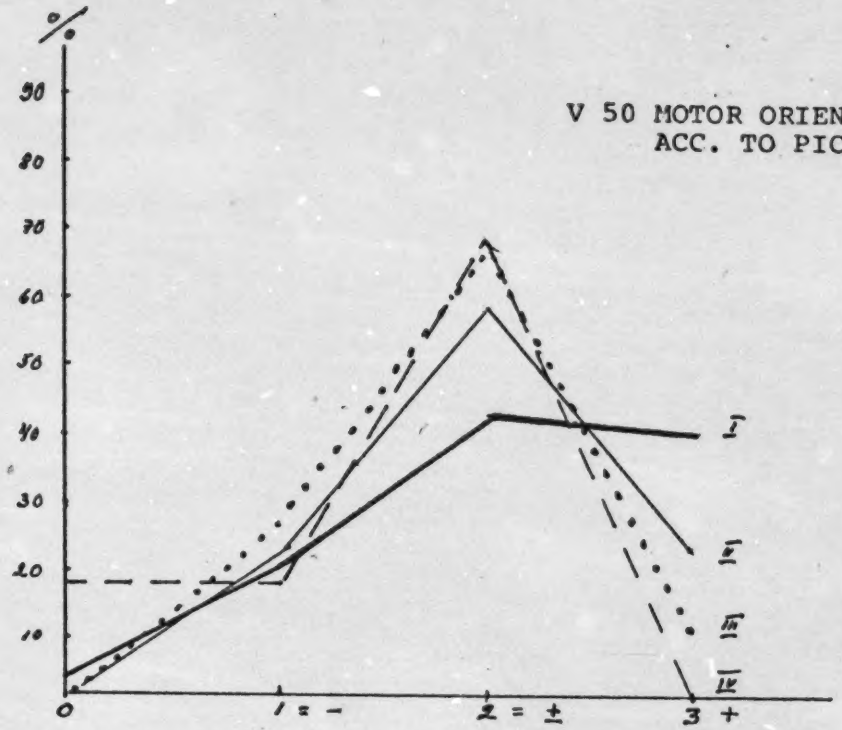
V 48 MOTOR ORIENT. - HANDS

FIGURE 14



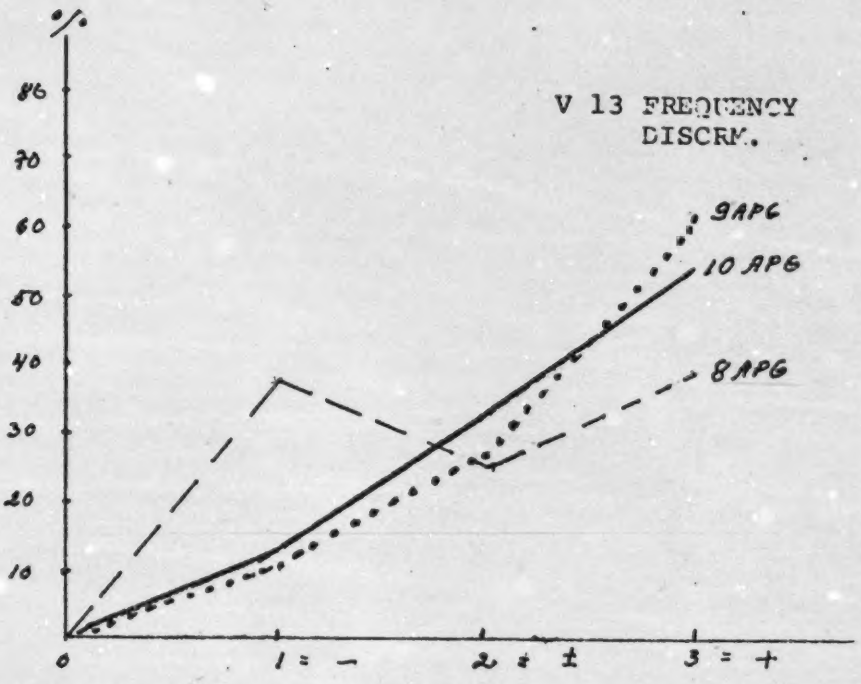
V 49 MOTOR ORIENT. - ARMS

FIGURE 15



V 50 MOTOR ORIENT. - ACC. TO PICTURE

FIGURE 16



V 13 FREQUENCY DISCRM.

FIGURE 17

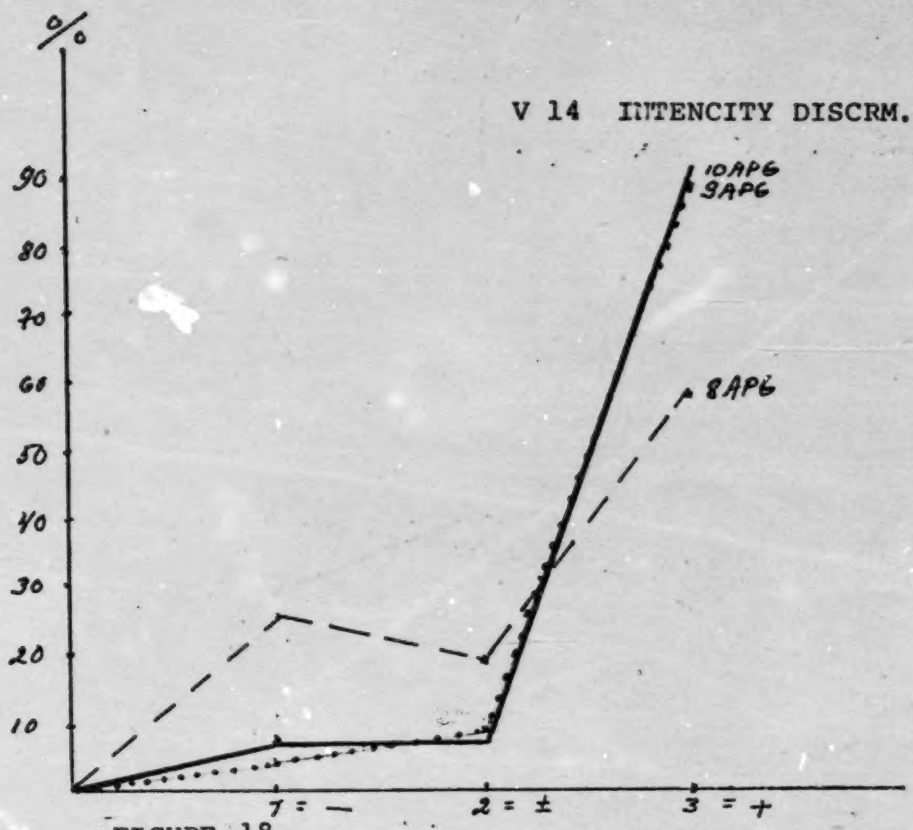


FIGURE 18

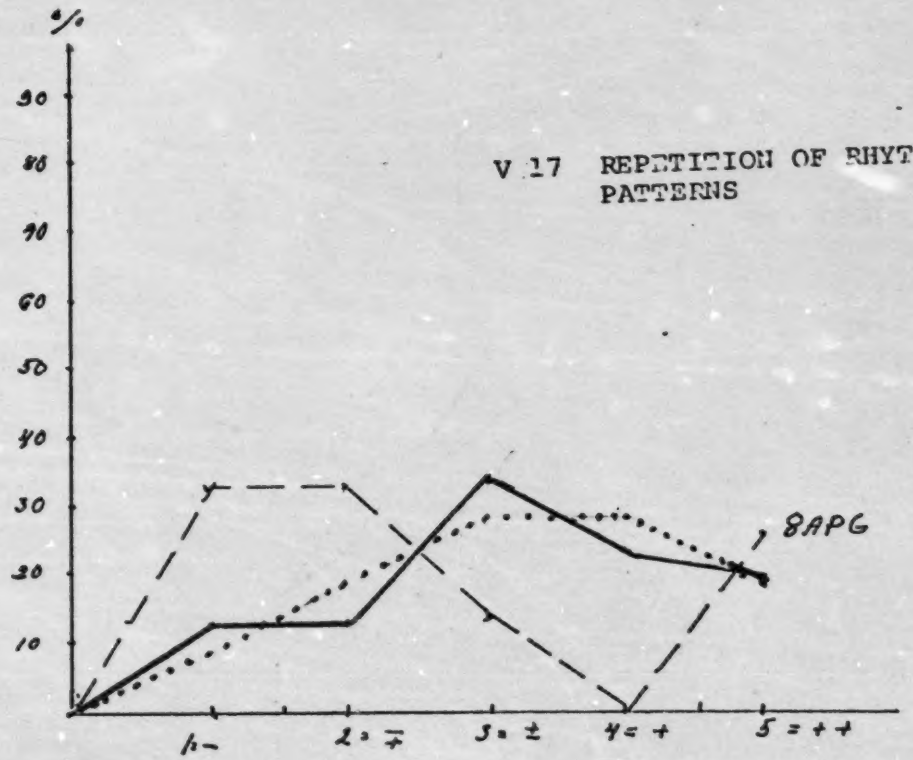


FIGURE 19

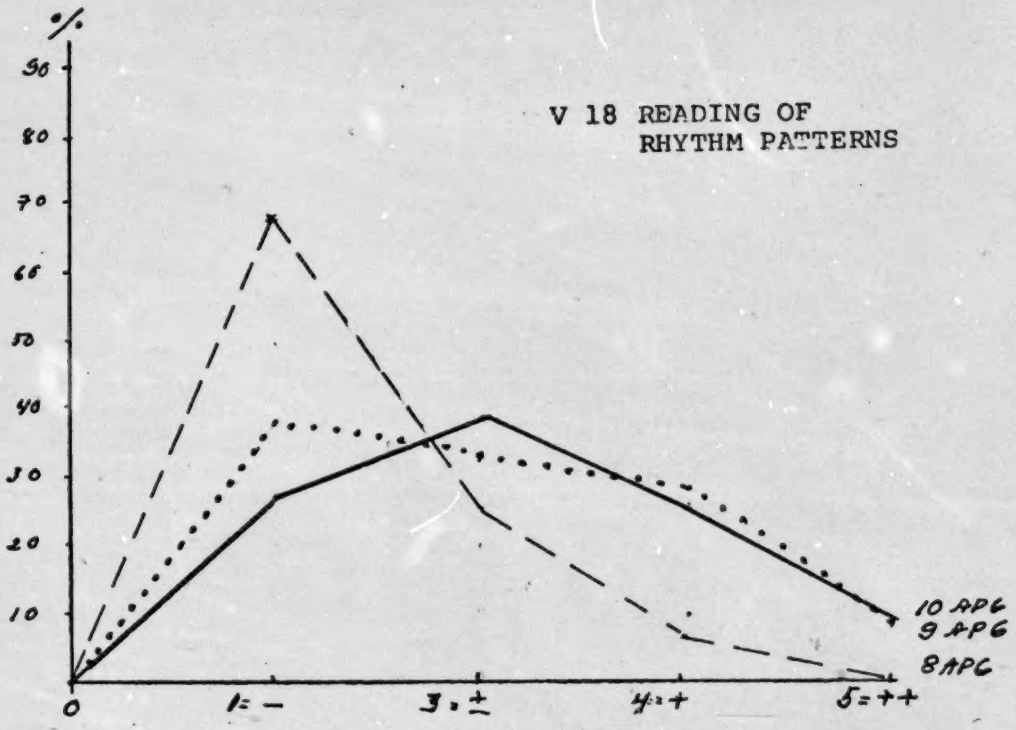


FIGURE 20

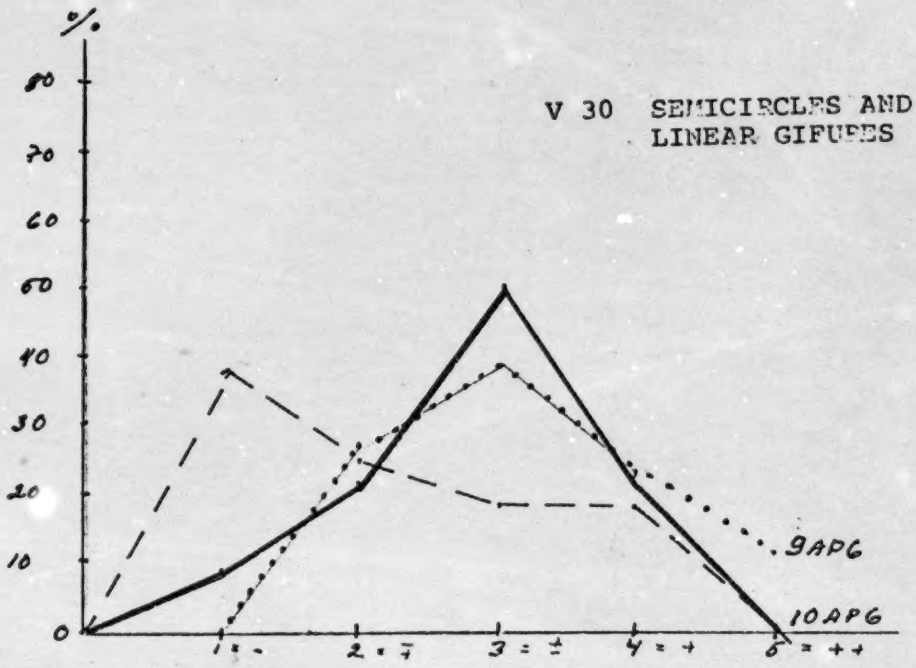
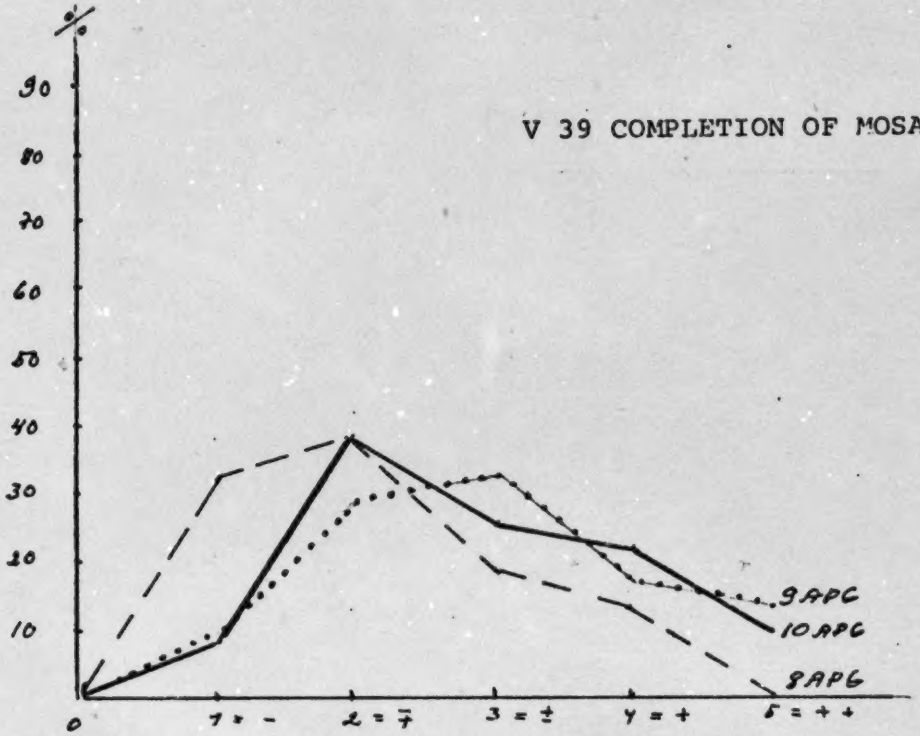
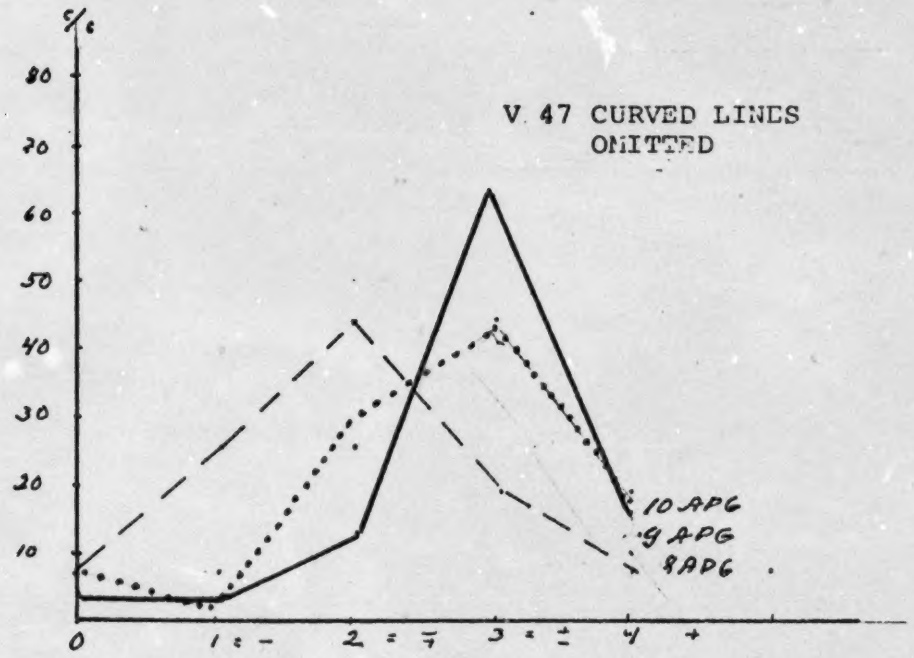


FIGURE 21



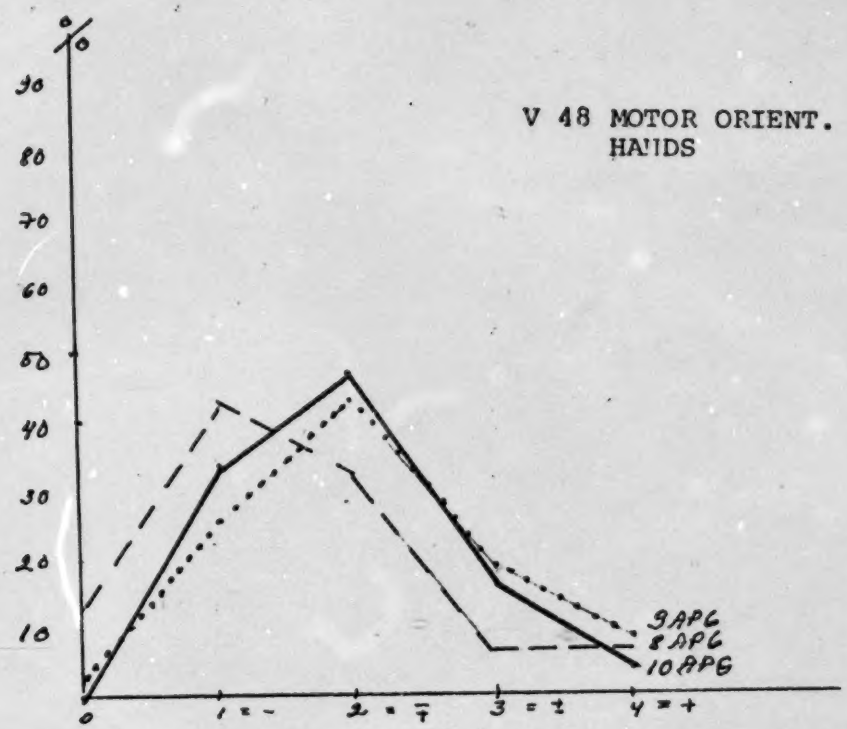
V 39 COMPLETION OF MOSAICS

FIGURE 22



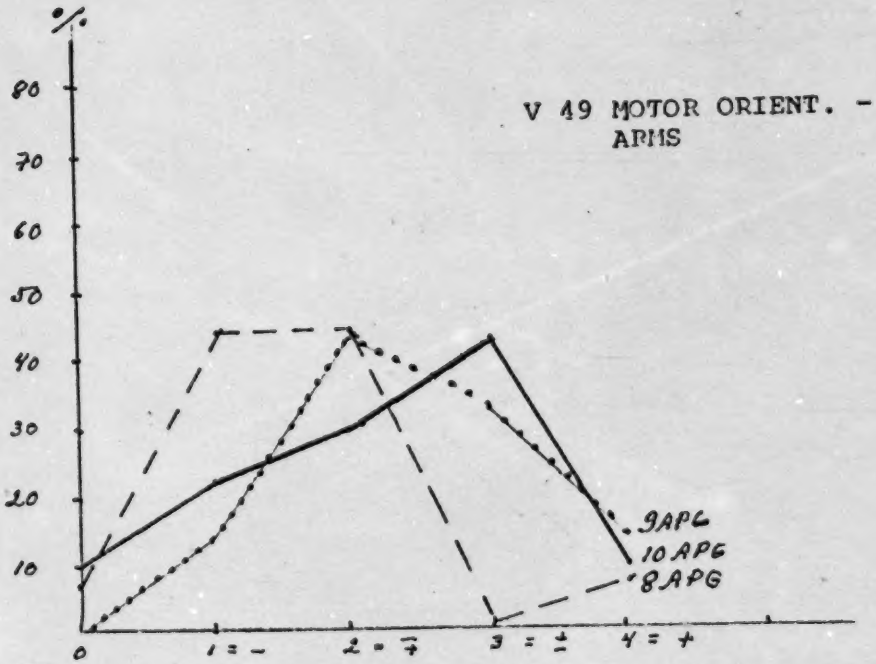
V 47 CURVED LINES OMITTED

FIGURE 23



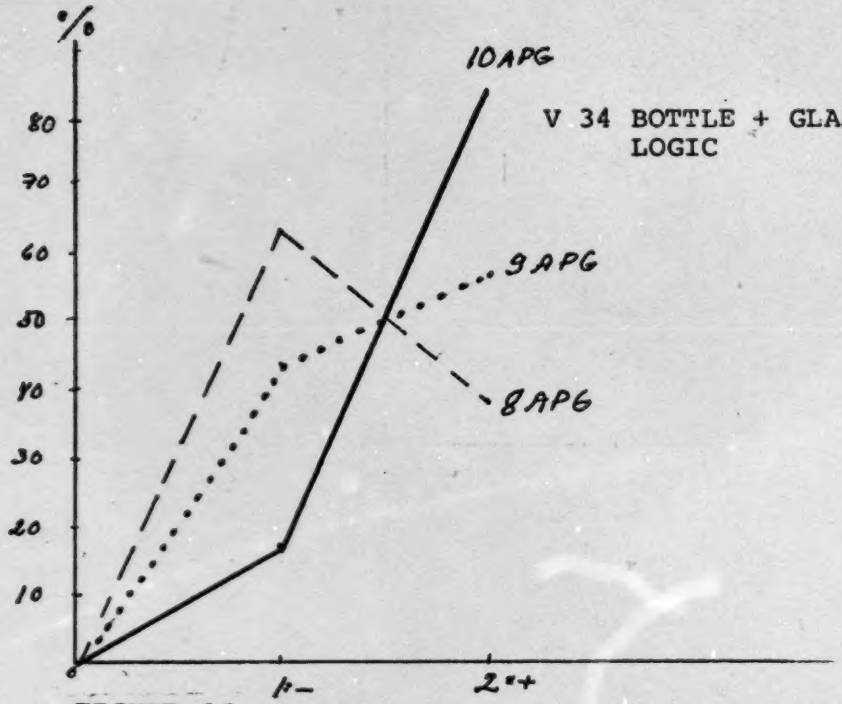
V 48 MOTOR ORIENT. - HANDS

FIGURE 24



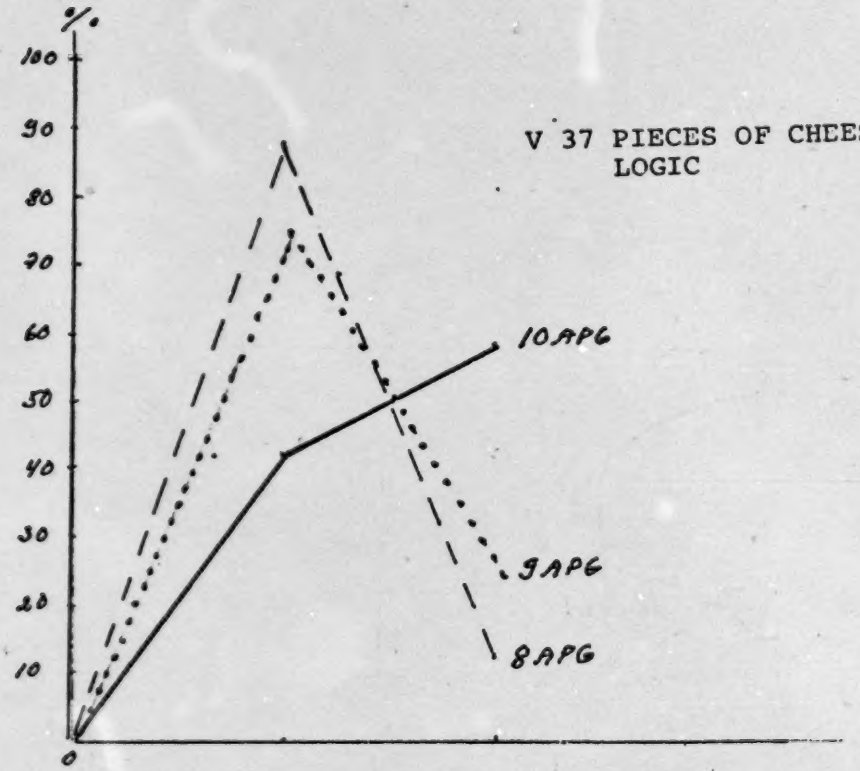
V 49 MOTOR ORIENT. - ARMS

FIGURE 25



V 34 BOTTLE + GLASSES - LOGIC

FIGURE 26



V 37 PIECES OF CHEESE - LOGIC

FIGURE 27

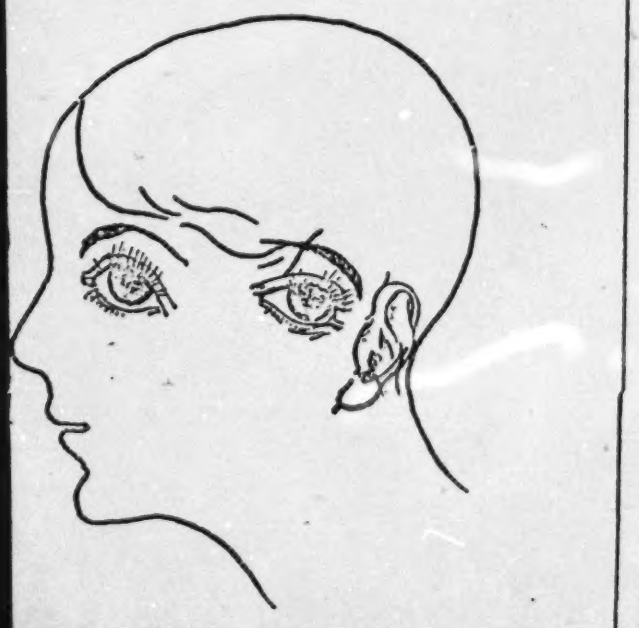
Performances of the Apgar groups in the Profile Completion Test

8APG (5 y.9 m.)

8APG (6 y.)

8APG (6 y.3 m.)

8APG (6 y.6 m.)



Performances of the Apgar groups in the Profile Completion Test

8APG (6 y.)

8APG (6 y.)

8APG (5 y. 9 m.)

8APG (6 y.)

APPENDIX 5 a Intercorrelations of the different variables

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
12	1000																		
13	.260	1000																	
14	.343	.304	1000																
15	.207	.301	.213	1000															
16	.084	.168	.089	.306	1000														
17	.340	.267	.400	.214	.018	1000													
18	.171	.285	.240	.274	.137	.592	1000												
19	.098	.231	.280	.127	.045	.281	.109	1000											
20	.000	.000	.000	.000	.000	.000	.000	.000	1000										
21	-.016	-.052	.087	.084	-.025	.105	.039	.079	.000	1000									
22	.324	.454	.371	.240	.174	.229	.291	.099	.000	.115	1000								
23	.166	.127	.360	.174	.160	.049	-.016	.158	.000	.041	.212	1000							
24	.119	.020	.097	-.113	.054	-.124	-.123	-.034	.000	.002	.054	.238	1000						
25	.065	.227	.085	.314	.060	.177	.139	.193	.000	.191	.200	.048	-.069	1000					
26	.328	.075	.115	.203	.110	.202	.141	.009	.000	.079	.151	.240	.181	.171	1000				
27	.071	.154	-.040	.092	.078	.008	.154	-.097	.000	.020	.082	.047	.033	.033	.215	1000			
28	.101	.105	.112	.192	.141	.137	.266	.174	.000	.128	.201	.149	.107	.194	.424	.351	1000		
29	.184	.187	.360	.008	.190	.113	.013	.185	.000	.055	.211	.259	.089	.081	.117	.224	.304	1000	
30	.221	.188	.182	.179	.014	.208	.163	.298	.000	-.053	.338	.179	-.061	.128	.195	.165	.336	.267	1000

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APPENDIX 5 b Intercorrelations of the different variables

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
31	.045	.211	.154	-.007	.132	.046	.135	.132	.000	.098	.068	.012	.096	.160	-.042	.208	.250	.081
32	.054	.074	.318	.121	.101	.125	.256	.217	.000	.087	.178	.296	.056	.123	.235	.138	.353	.225
33	.145	-.125	.001	-.144	.020	.065	.011	-.220	.000	-.047	.022	.002	.002	-.136	.213	.062	.115	.193
34	.087	.038	.178	-.057	.162	-.019	.176	-.094	.000	.098	.220	.165	.140	-.186	.157	.356	.246	.228
35	.274	.229	.111	.059	.108	.165	.172	.093	.000	-.018	.330	.198	.142	.027	.303	.254	.287	.305
36	.205	-.065	-.014	-.011	.126	.075	.051	-.212	.000	.021	-.022	-.025	.068	-.092	.264	.154	.221	.212
37	.093	.006	.113	-.061	-.006	.066	.175	-.050	.000	-.003	.031	-.026	.005	-.159	.426	.055	.246	.173
38	.085	.133	.067	-.073	-.002	.139	.122	.046	.000	-.068	-.016	.055	.039	-.064	.108	.325	.200	.179
39	.199	.185	.266	.076	.013	.349	.373	.157	.000	-.003	.292	.186	-.018	.226	.228	.118	.272	.180
40	-.030	.201	.235	.073	-.092	-.028	-.022	.193	.000	-.039	.093	.267	.105	.145	.246	.025	.085	.218
41	-.055	.234	.110	.042	-.027	-.034	-.025	.185	.000	.026	.187	.196	.191	.185	.264	.152	.291	.264
42	.071	.217	.141	.078	-.024	-.044	.026	.159	.000	-.059	.171	.188	.068	.152	.209	-.056	.126	.193
43	-.022	.172	.118	.113	.027	.016	.077	.122	.000	.051	.184	-.050	..186	.108	.101	-.110	-.097	-.263
44	.108	.055	.087	.113	.162	.154	.186	-.009	.000	.028	.048	-.020	-.098	.103	.145	.327	.200	.052
45	-.104	.152	-.108	.119	.010	-.016	.078	-.028	.000	.051	.139	.171	-.060	.066	.174	.135	.185	-.117
46	.194	.099	.229	.109	.084	.297	.302	.096	.000	.067	.066	.049	.028	.028	.181	.278	.342	.117
47	.060	.247	.133	.039	.092	.200	.222	.235	.000	.030	.202	.139	.050	.084	.269	.315	.403	.158
48	.045	.053	.118	.177	.131	.115	.104	.134	.000	.032	.037	.290	.151	.147	.264	.259	.226	.307
49	.208	.132	.201	.090	.150	.219	.119	.174	.000	.109	.115	.327	.072	.250	.263	.222	.293	.351
50	.087	.270	.000	.075	.077	.212	.263	.187	.000	.017	.107	.142	.000	.188	.189	.280	.202	.185
51	.054	-.039	.013	-.058	.148	.022	.005	-.104	.000	-.192	-.045	.058	-.033	-.054	.099	.107	-.080	.129

APPENDIX 5 c Intercorrelations of the different variables .

	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
31	.081	1000																				
32	.072	.238	1000																			
33	.071	.045	.057	1000																		
34	.024	.134	.290	.196	1000																	
35	.358	.130	-.197	.188	.378	1000																
36	.113	.149	.077	.800	.147	.211	1000															
37	.173	.161	.175	.105	.356	.150	.123	1000														
38	.195	.170	.165	.217	.207	.297	.192	.447	1000													
39	.331	.210	.206	.078	.219	.166	.051	.204	.104	1000												
40	.111	.121	.182	-.011	-.017	.137	.069	.002	.160	.158	1000											
41	.272	.205	.156	-.021	.133	.191	.041	.186	.206	.269	.533	1000										
42	.070	.178	.272	.052	.009	.124	.125	-.064	.011	.117	.789	.502	1000									
43	.181	.232	.261	.085	.327	.278	.209	.330	.208	.289	.318	.648	.340	1000								
44	.135	.164	.115	.150	.286	.155	.222	.111	.136	.270	-.074	.022	-.104	.116	1000							
45	.271	.030	.174	.068	.025	.096	.137	.053	.164	.153	.071	.187	.031	.093	.171	1000						
46	.341	.222	.121	.081	.216	.337	.252	.206	.432	.223	.053	.178	-.015	.317	.335	.243	1000					
47	.342	.148	.204	-.037	.190	.166	.056	.102	.257	.336	.109	.288	.059	.211	.345	.285	.362	1000				
48	.287	.105	.128	.183	.065	.198	.292	.035	.198	.167	.174	.167	.148	.248	.122	-.032	.336	.084	1000			
49	.277	.208	.126	.074	.111	.332	.192	.000	.127	.263	.199	.257	.207	.290	.182	-.013	.401	.202	.731	1000		
50	.280	.218	.173	-.054	.000	.226	.082	.267	.360	.036	.069	.127	.057	.264	.080	.200	.309	.140	.347	.413	1000	
51	.028	.067	.187	.349	.151	.188	.387	.119	.202	-.065	.087	-.101	.116	-.072	.041	.055	.000	-.005	..160	.072	.095	1000